

US011293505B2

(12) **United States Patent**
Barbosa

(10) **Patent No.:** **US 11,293,505 B2**
(45) **Date of Patent:** **Apr. 5, 2022**

(54) **UNI-DIRECTIONAL ANTI-ROTATION MEMBER FOR A DISC BRAKE ASSEMBLY WITH AN ELECTRIC PARKING BRAKE**

(58) **Field of Classification Search**
CPC F16D 65/095; F16D 65/18; F16D 65/0979;
F16D 2125/06; F16D 2125/40; F16D
2125/34

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See application file for complete search history.

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(73) Assignee: **ZF Active Safety US Inc.**, Livonia, MI (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 47 days.

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(21) Appl. No.: **16/958,791**

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(22) PCT Filed: **Dec. 26, 2018**

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(86) PCT No.: **PCT/US2018/067488**

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§ 371 (c)(1),
(2) Date: **Jun. 29, 2020**

Machine translation of WO 2017/150449 (no date).*

(87) PCT Pub. No.: **WO2019/133596**

Primary Examiner — Nicholas J Lane

PCT Pub. Date: **Jul. 4, 2019**

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(65) **Prior Publication Data**

(57) **ABSTRACT**

US 2020/0332849 A1 Oct. 22, 2020

A disc brake assembly includes a brake shoe, an anti-rotation member extending outward from the brake shoe, a displaceable brake piston that supports the brake shoe, an end face of the brake piston, and a recessed area in the end face. The brake shoe is displaceable along an axis. The end face is perpendicular to the axis and faces the brake shoe. The anti-rotation member has a stop surface and a diversion surface. The recessed area engages the stop surface to stop rotation of the brake piston in a first direction and the recessed area engages the diversion surface to allow rotation of the brake piston in a second direction. The first and second directions are opposite.

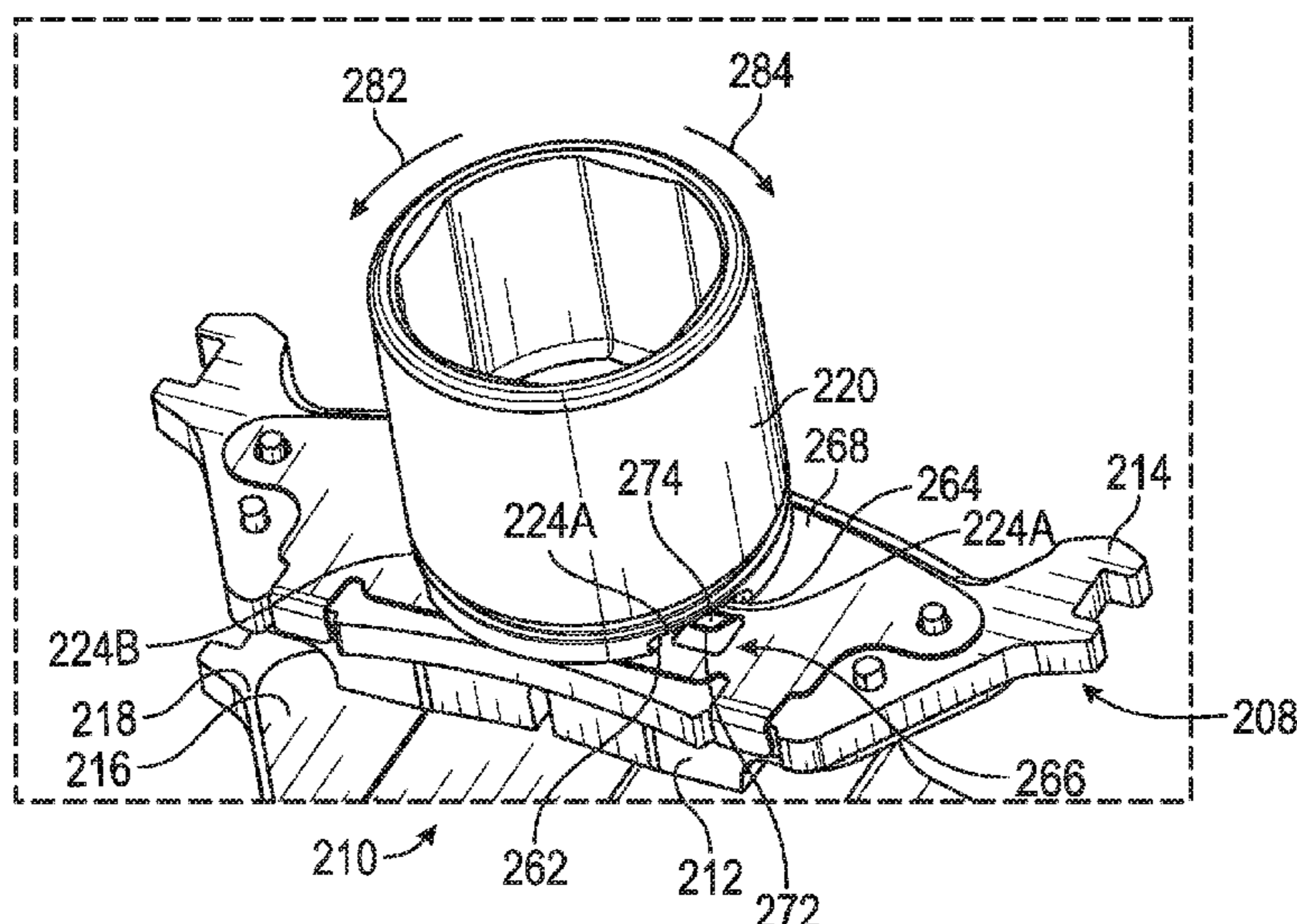
Related U.S. Application Data

(60) Provisional application No. 62/610,968, filed on Dec. 28, 2017.

(51) **Int. Cl.**
F16D 55/02 (2006.01)
F16D 65/18 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **F16D 65/18** (2013.01); **F16D 65/0979**
(2013.01); **F16D 2055/0016** (2013.01);
(Continued)

18 Claims, 15 Drawing Sheets



(51) **Int. Cl.**

F16D 65/097 (2006.01)
F16D 55/00 (2006.01)
F16D 123/00 (2012.01)
F16D 125/06 (2012.01)
F16D 125/40 (2012.01)

(52) **U.S. Cl.**

CPC *F16D 2123/00* (2013.01); *F16D 2125/06*
(2013.01); *F16D 2125/40* (2013.01)

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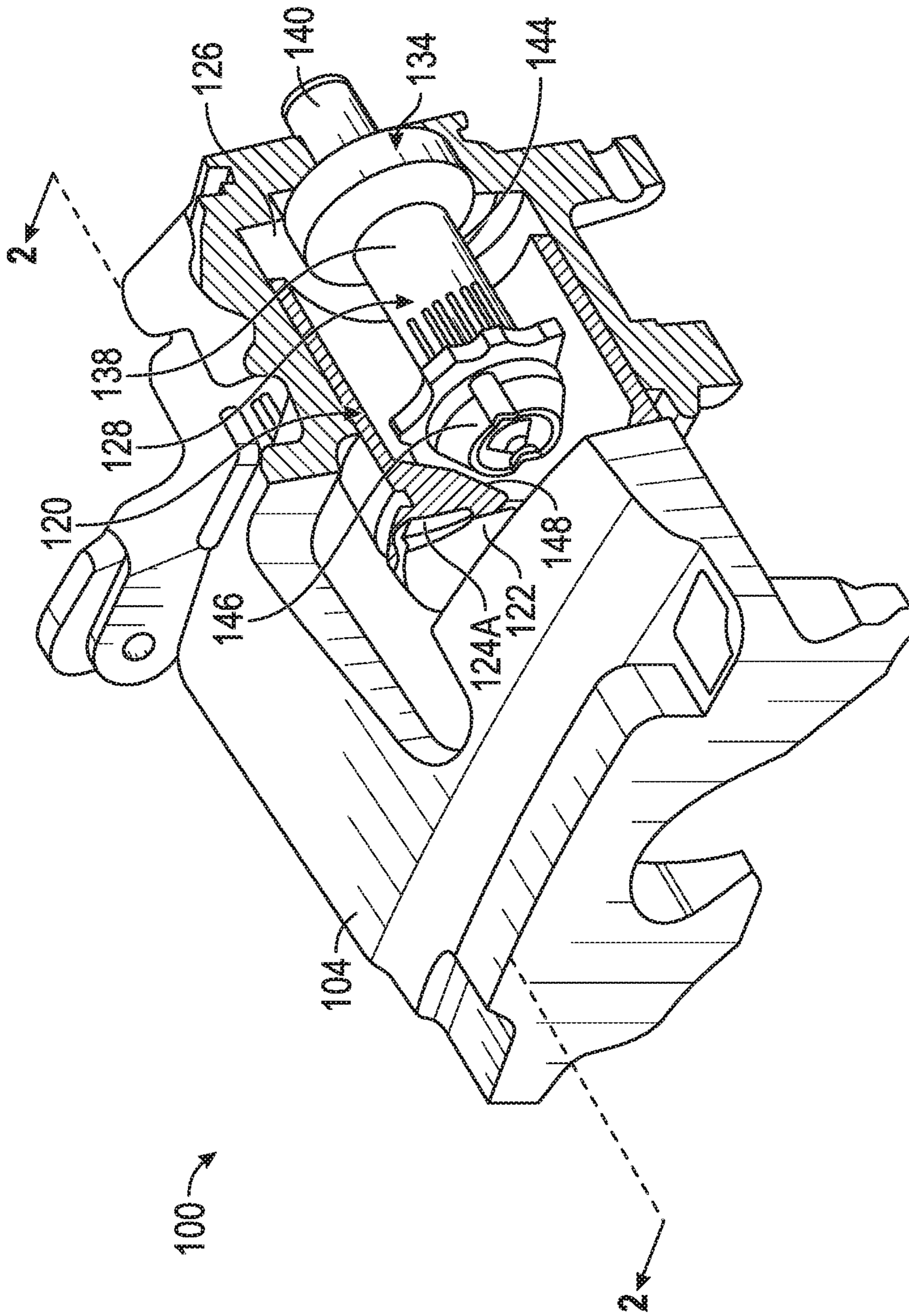


FIG. 1
(Prior Art)

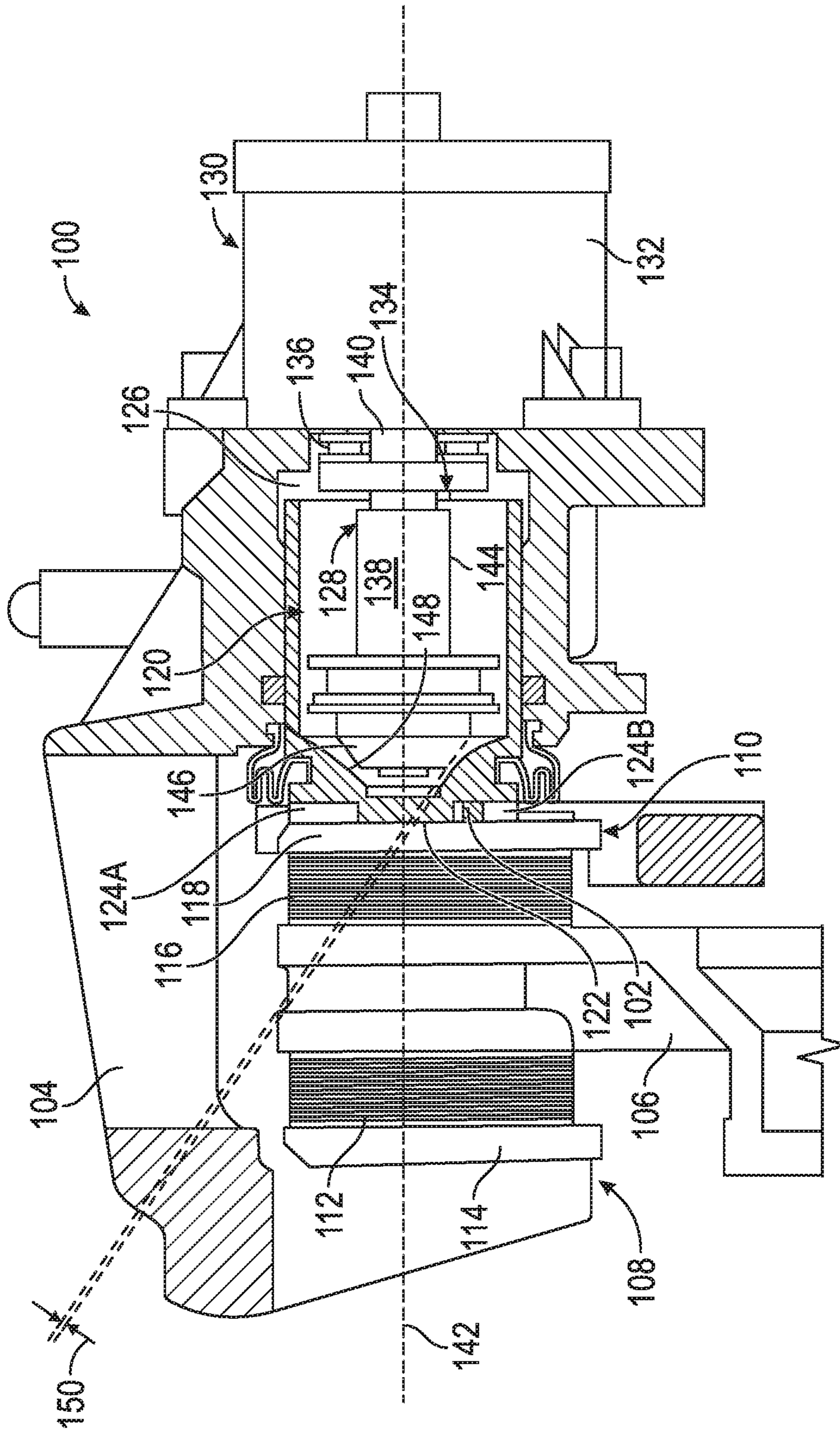


FIG. 2
(Prior Art)

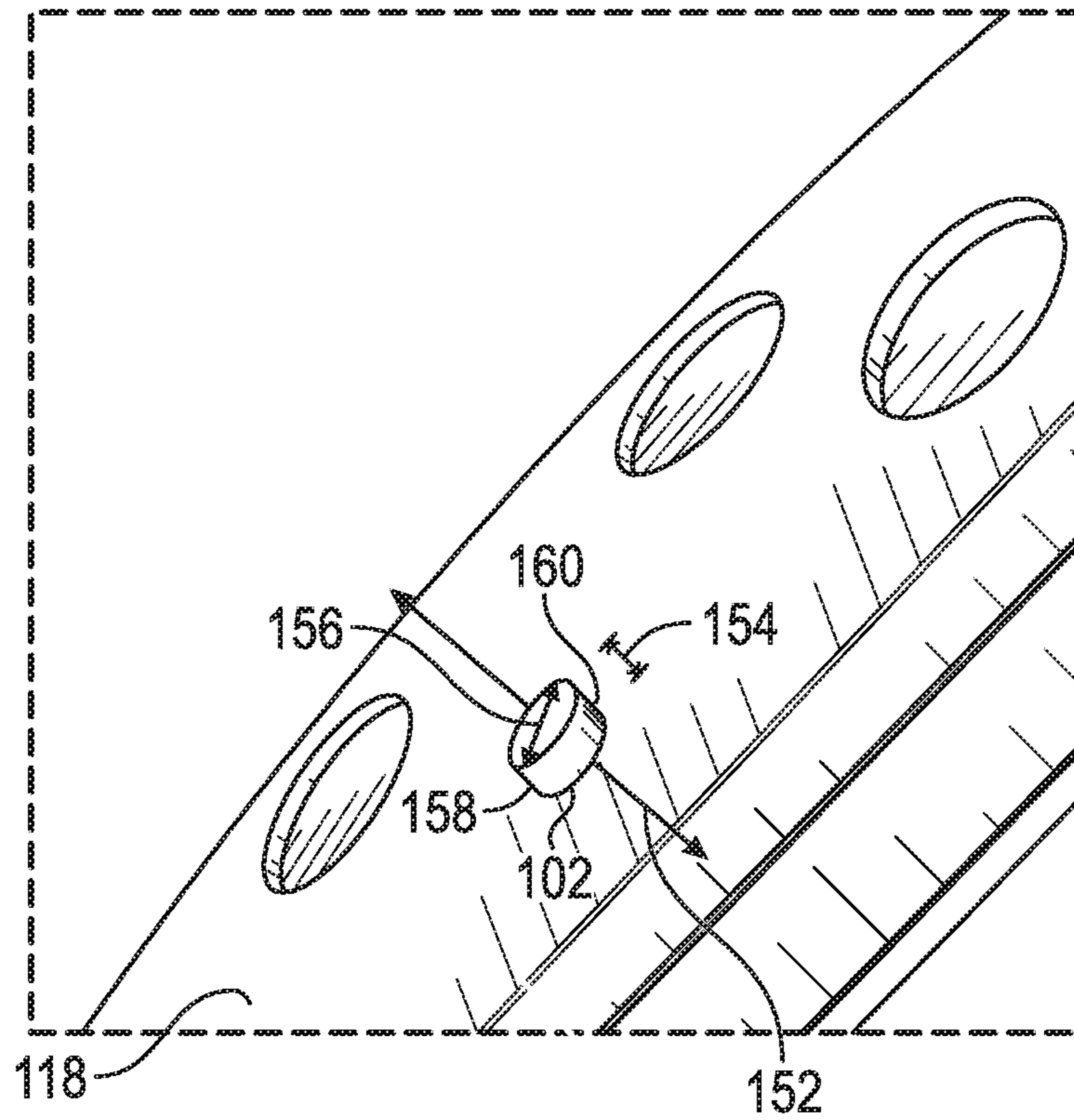


FIG. 3
(Prior Art)

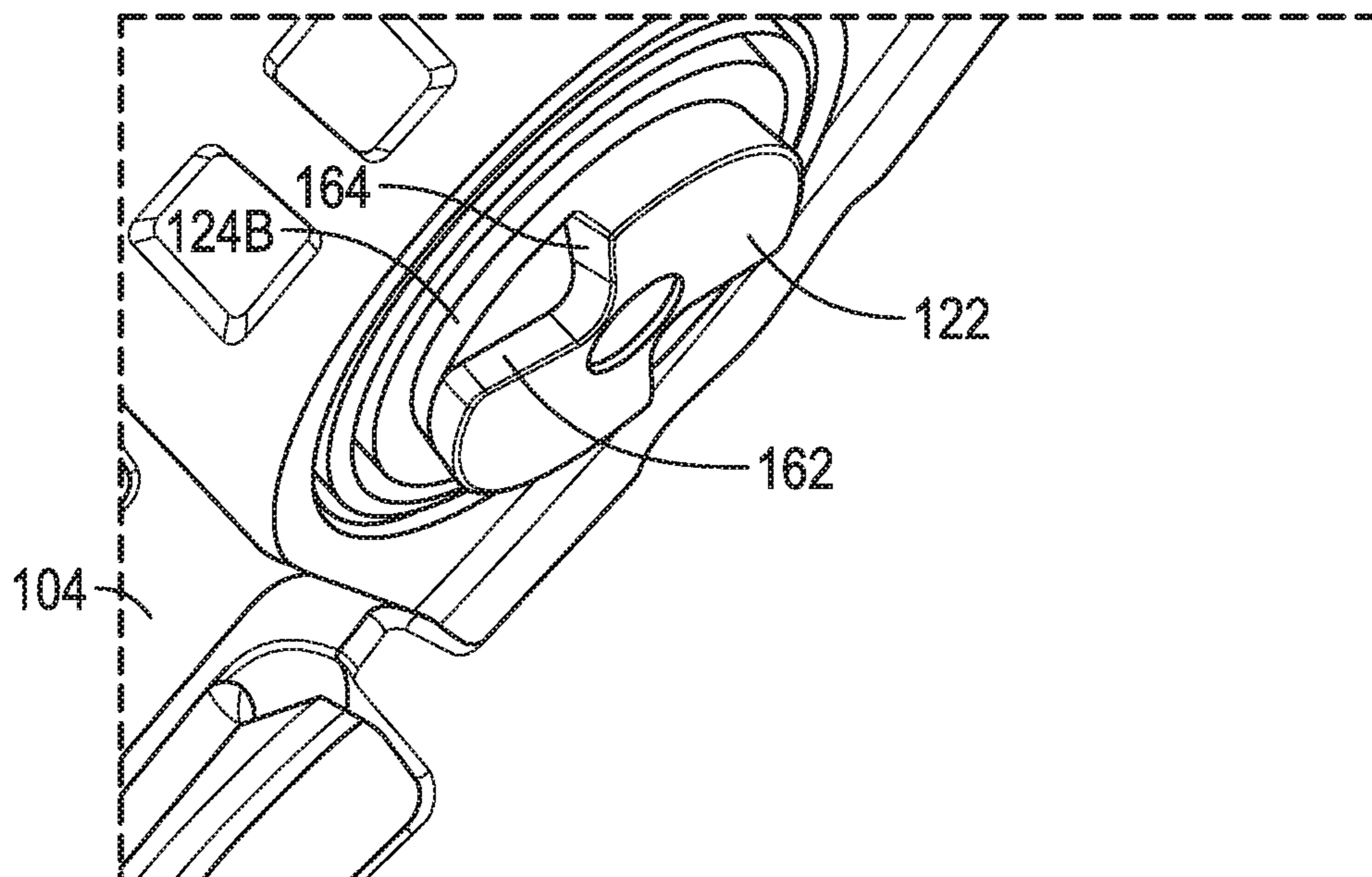


FIG. 4
(Prior Art)

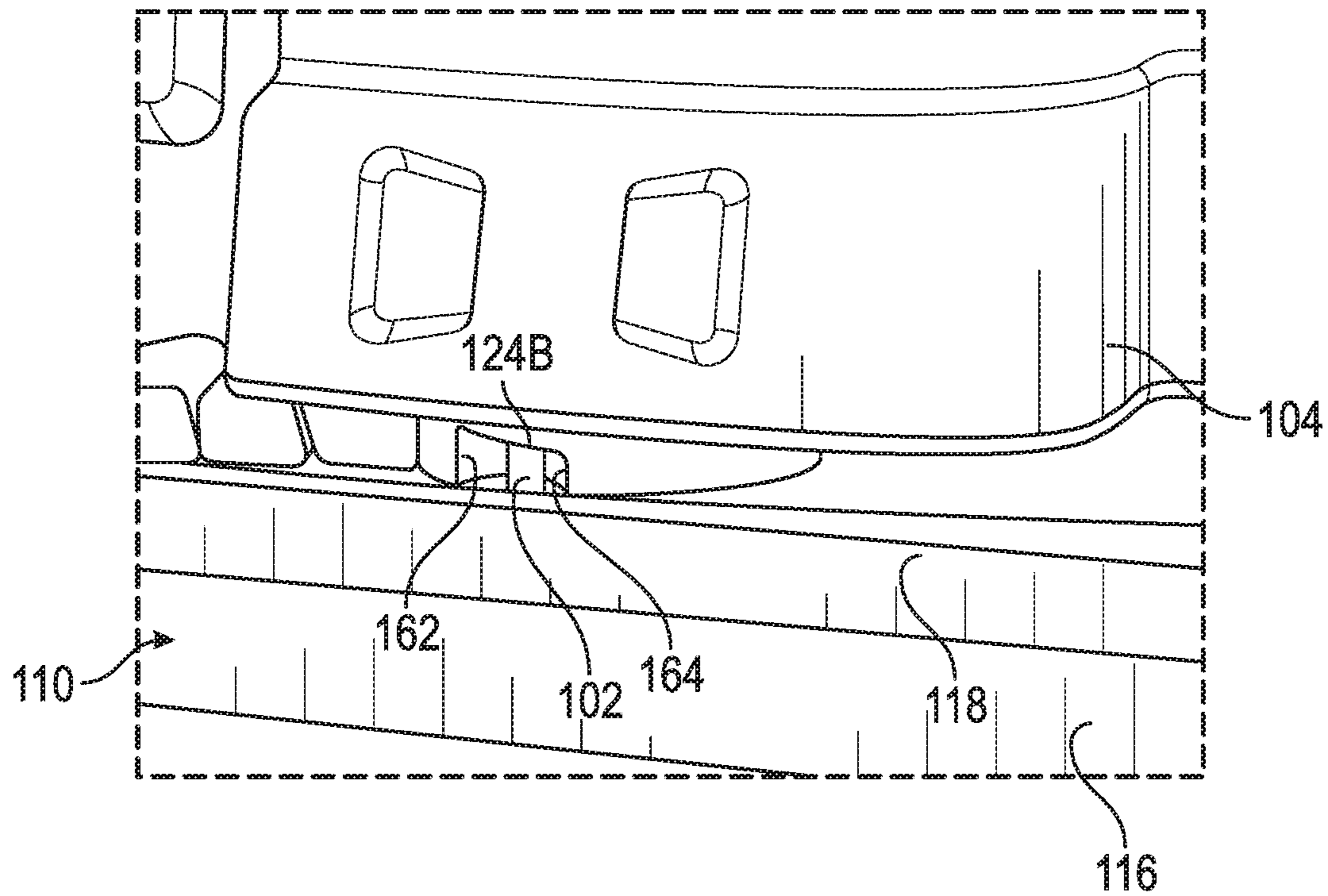


FIG. 5
(Prior Art)

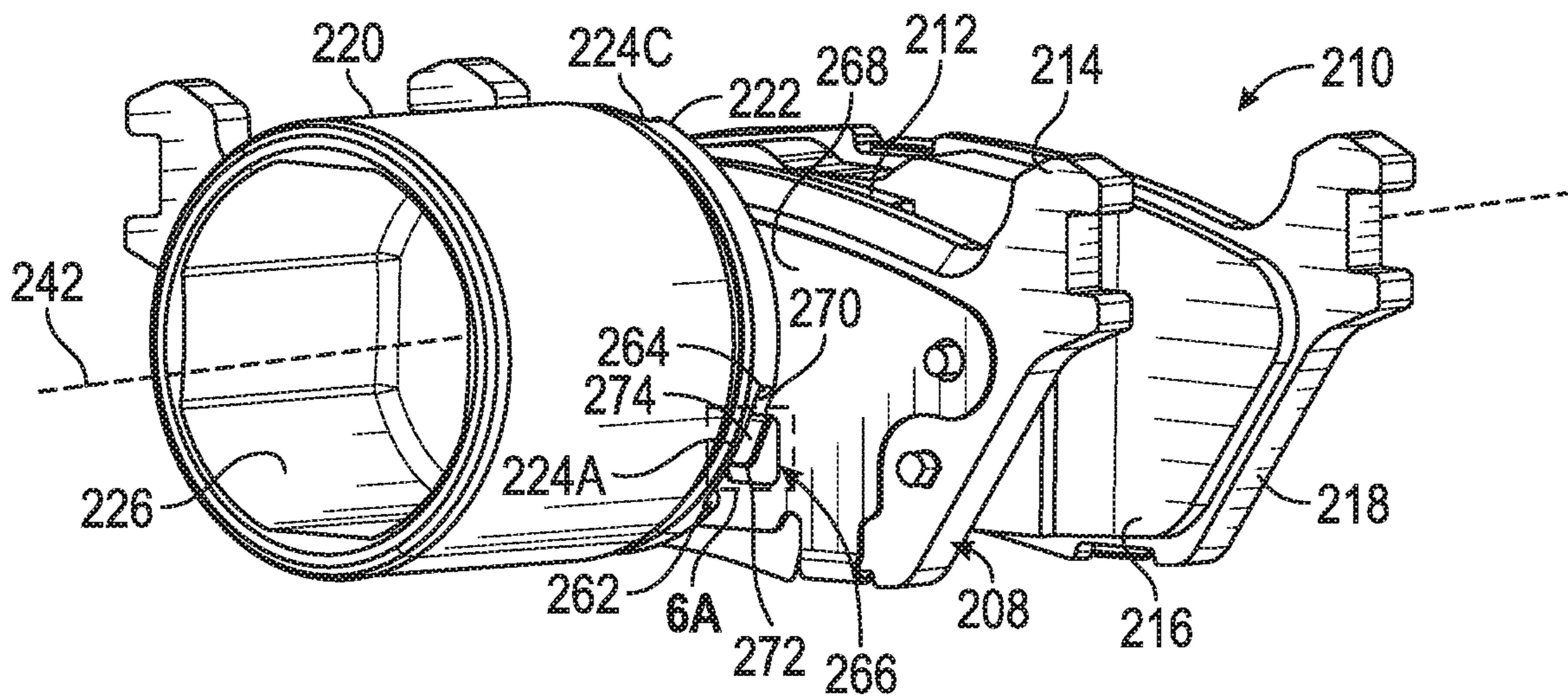


FIG. 6

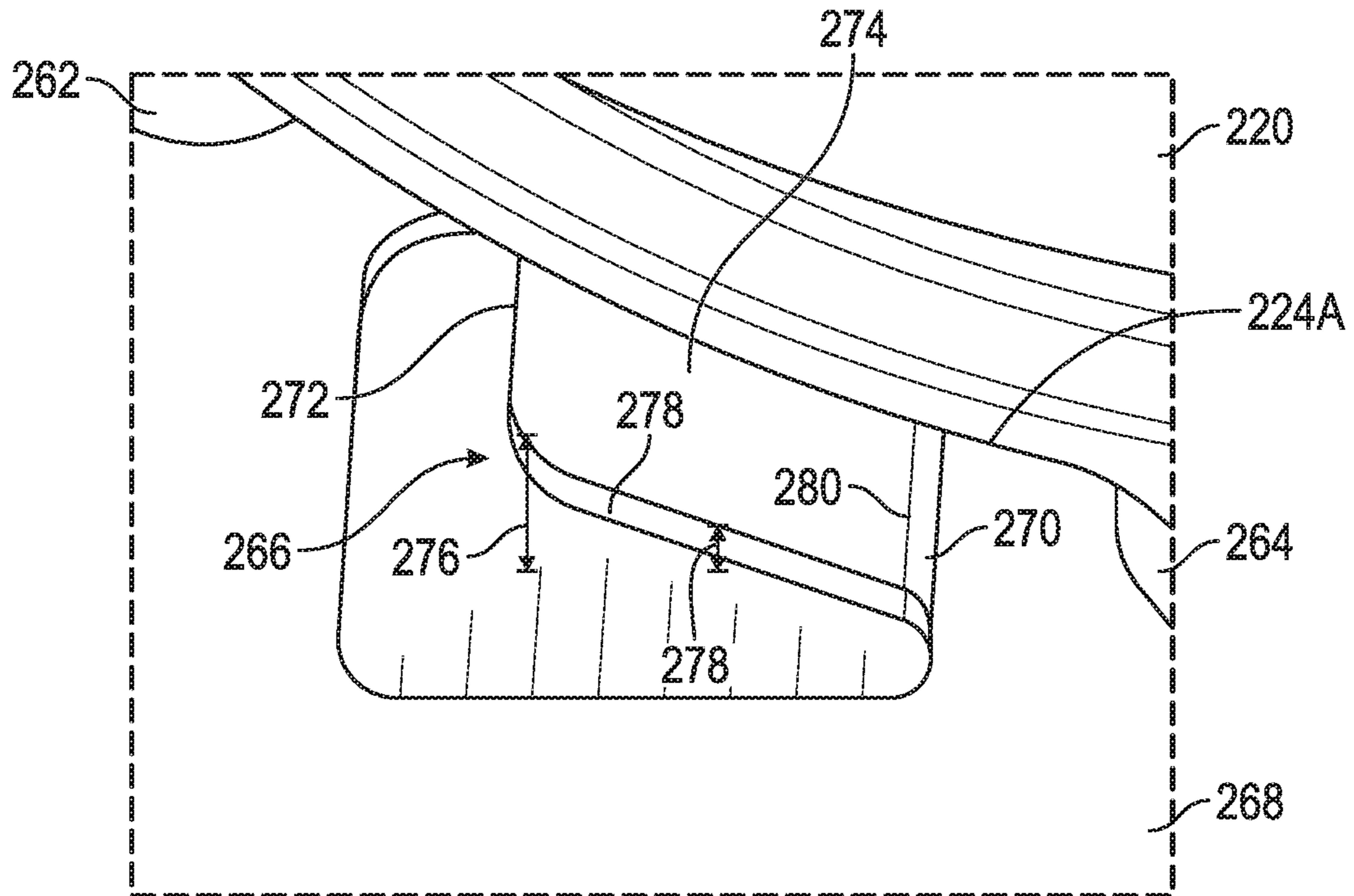


FIG. 6A

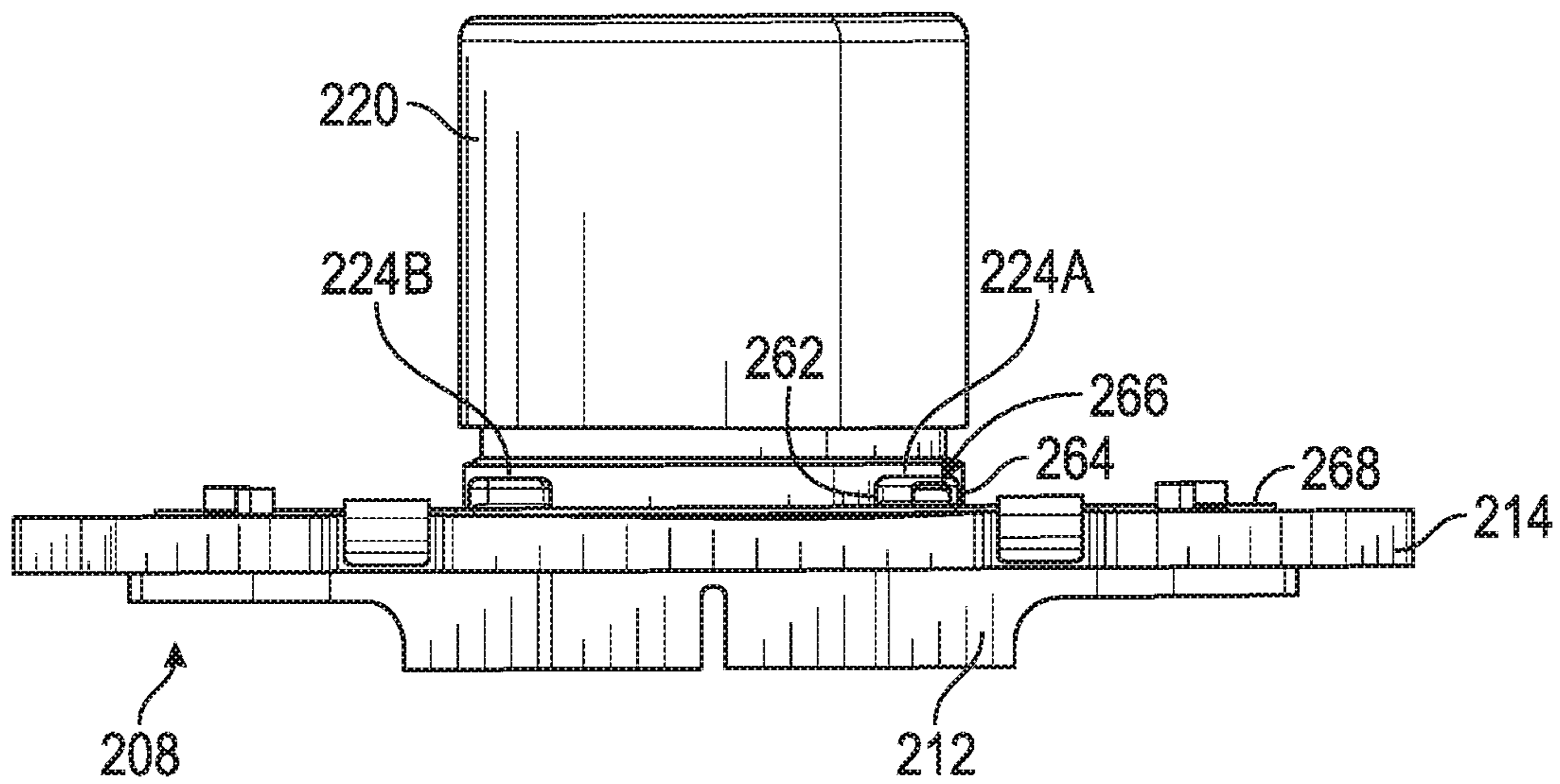


FIG. 7

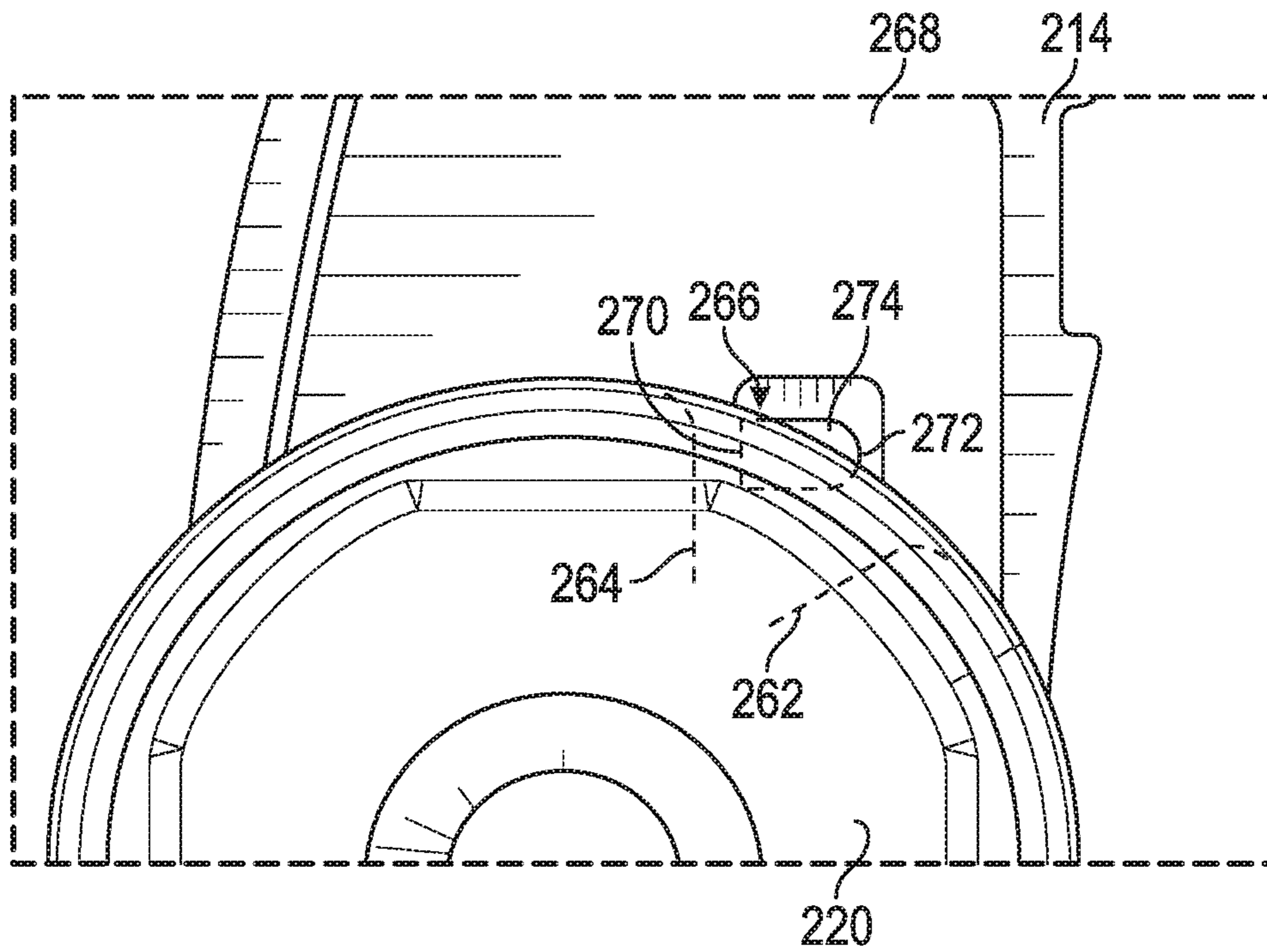


FIG. 8

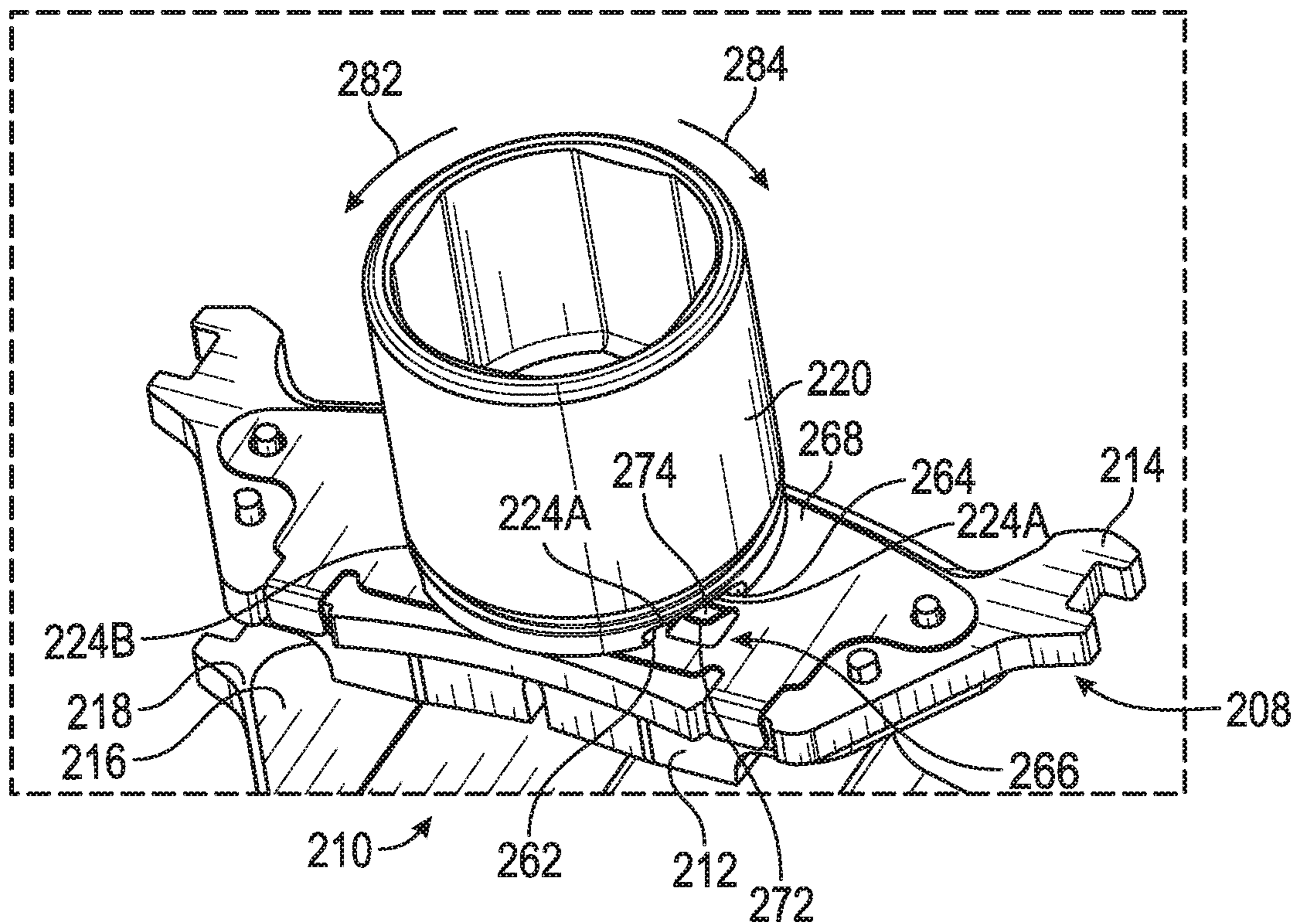


FIG. 9

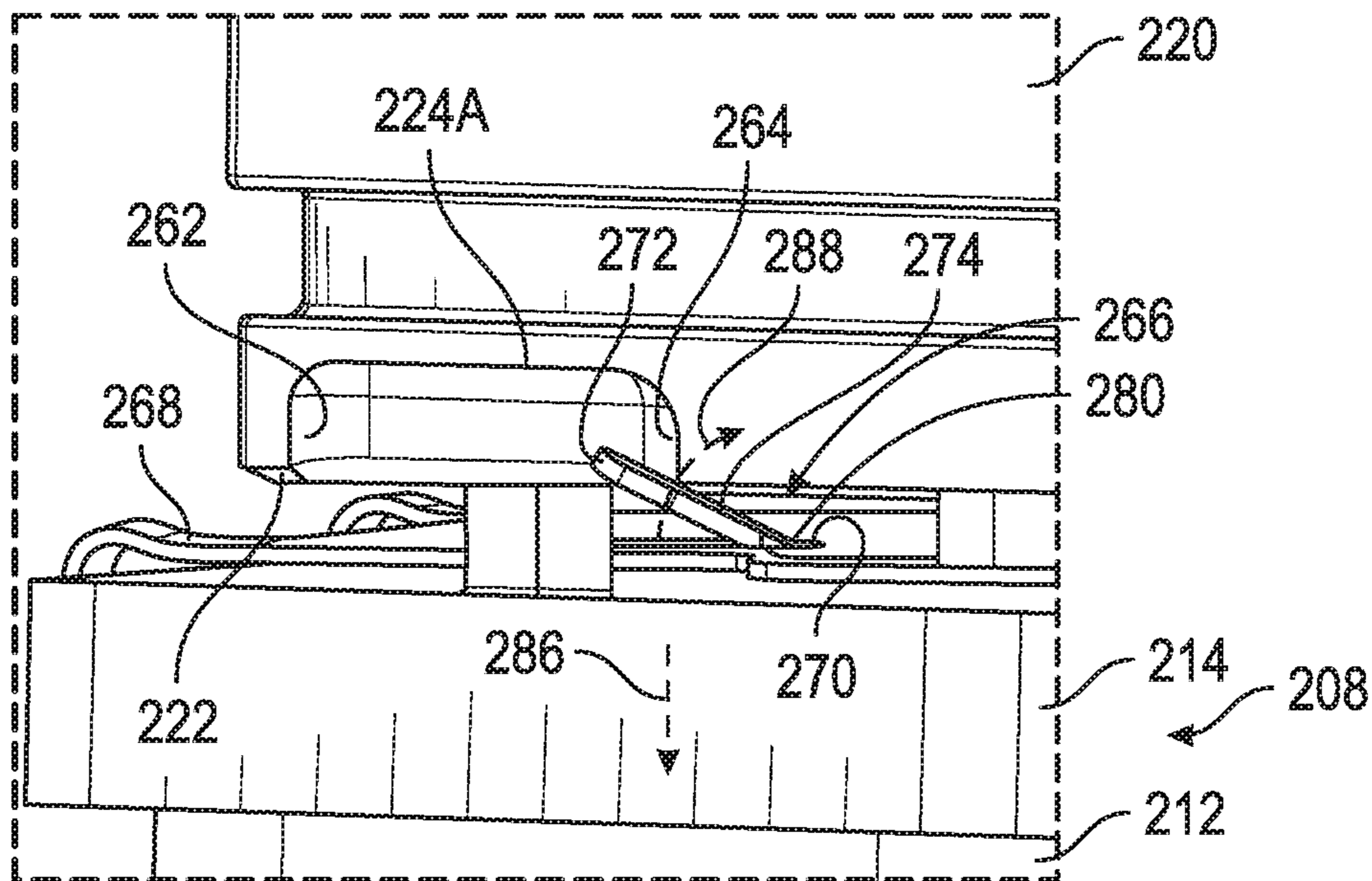


FIG. 12

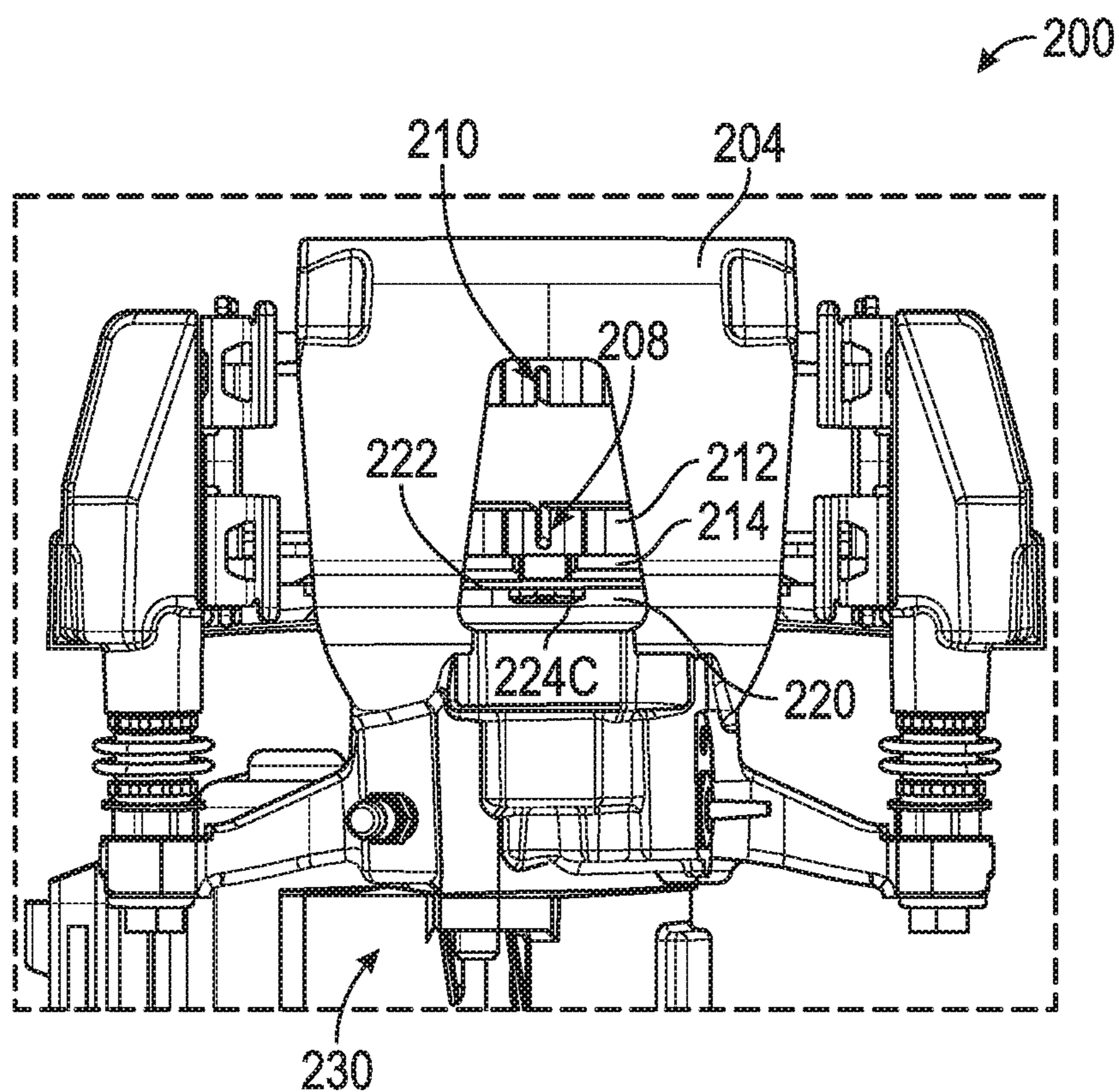


FIG. 13

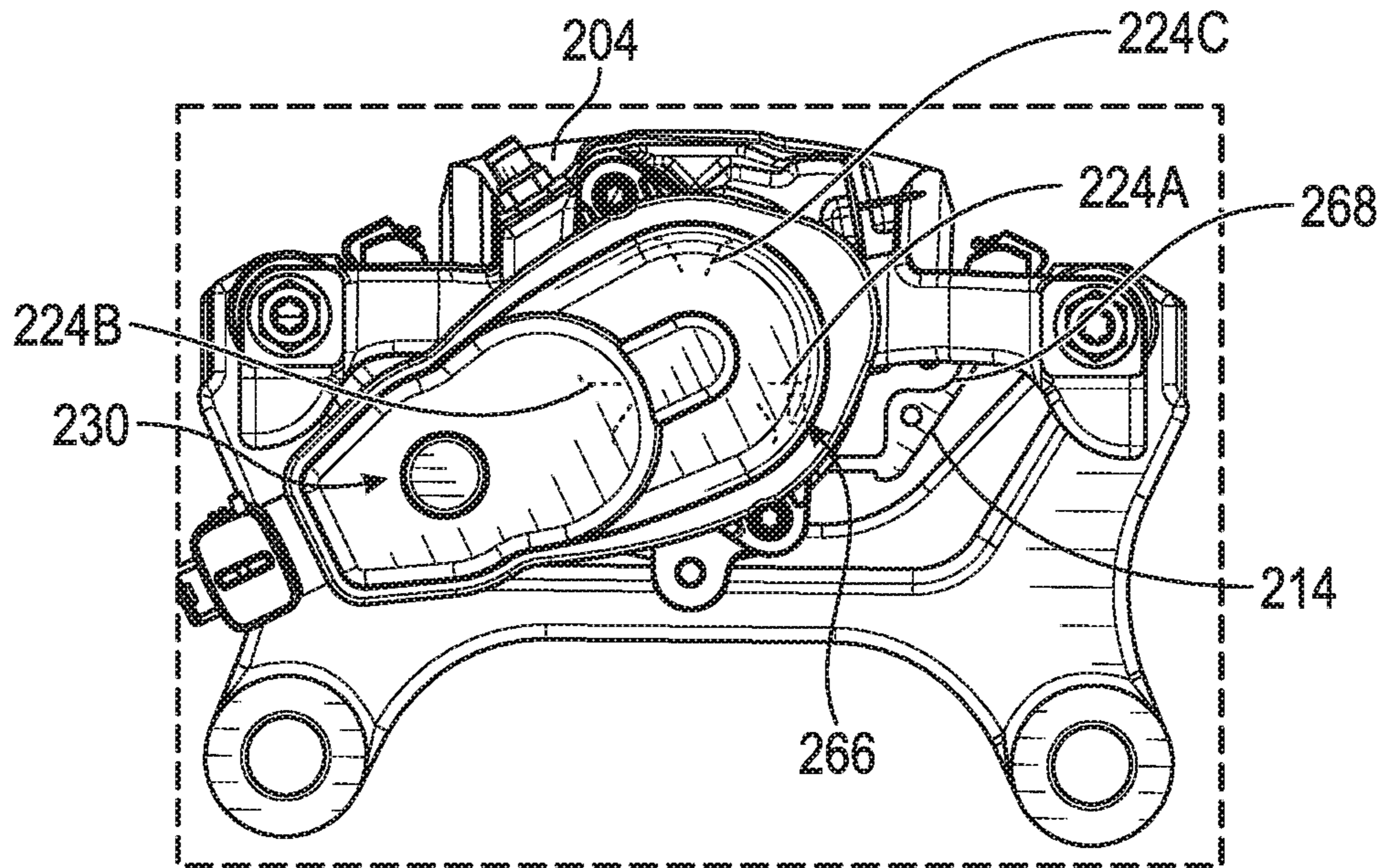


FIG. 14

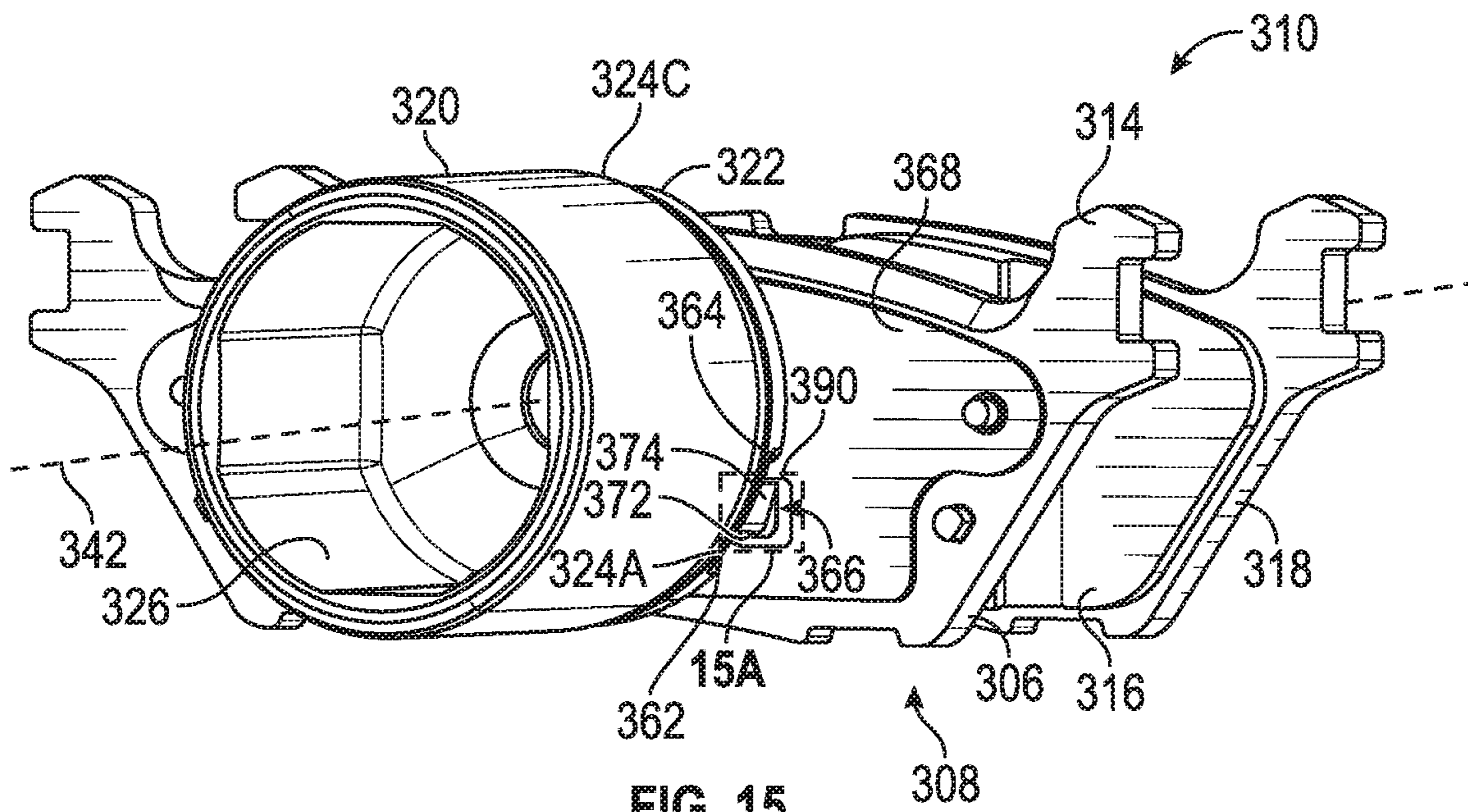


FIG. 15

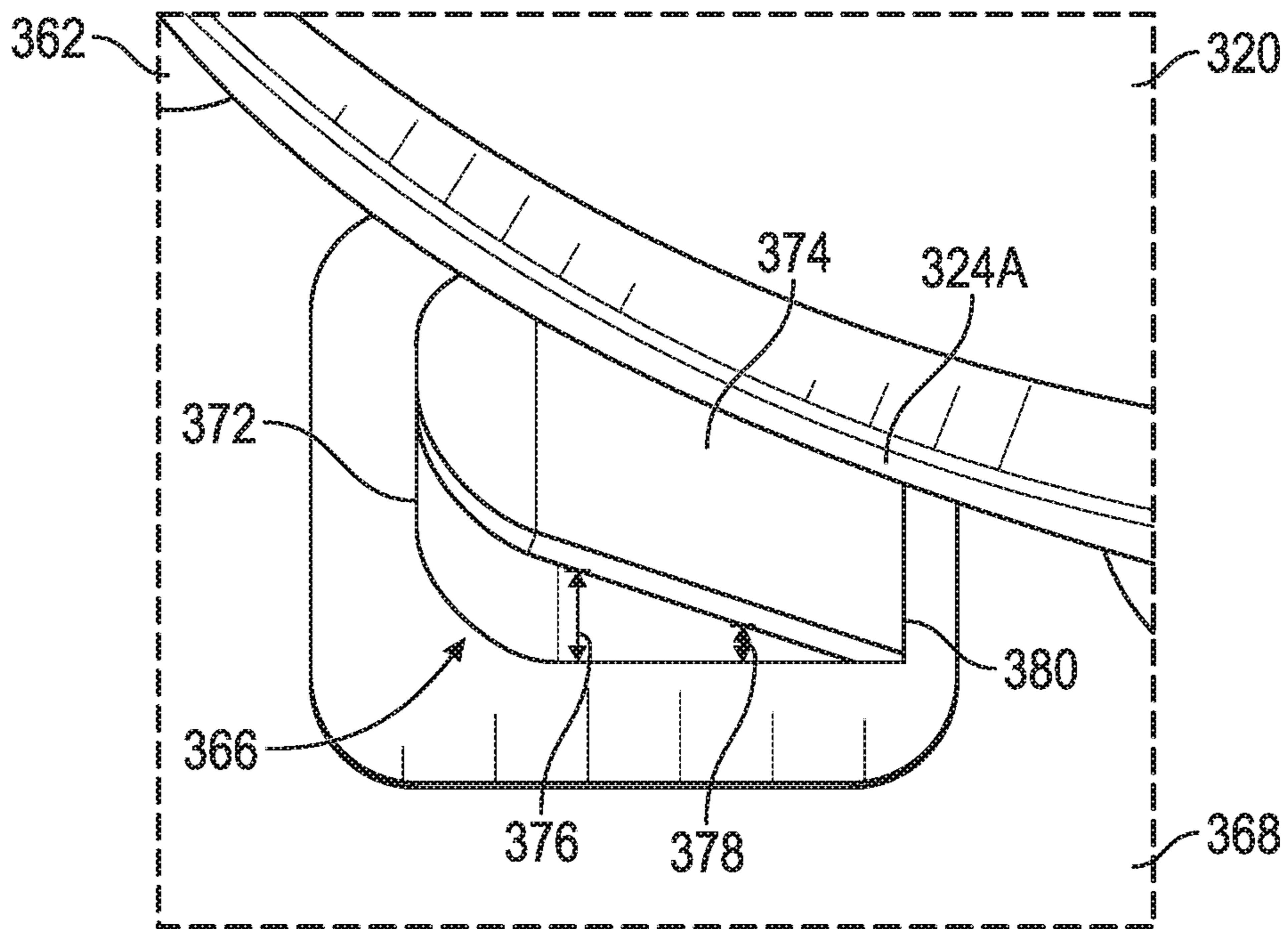


FIG. 15A

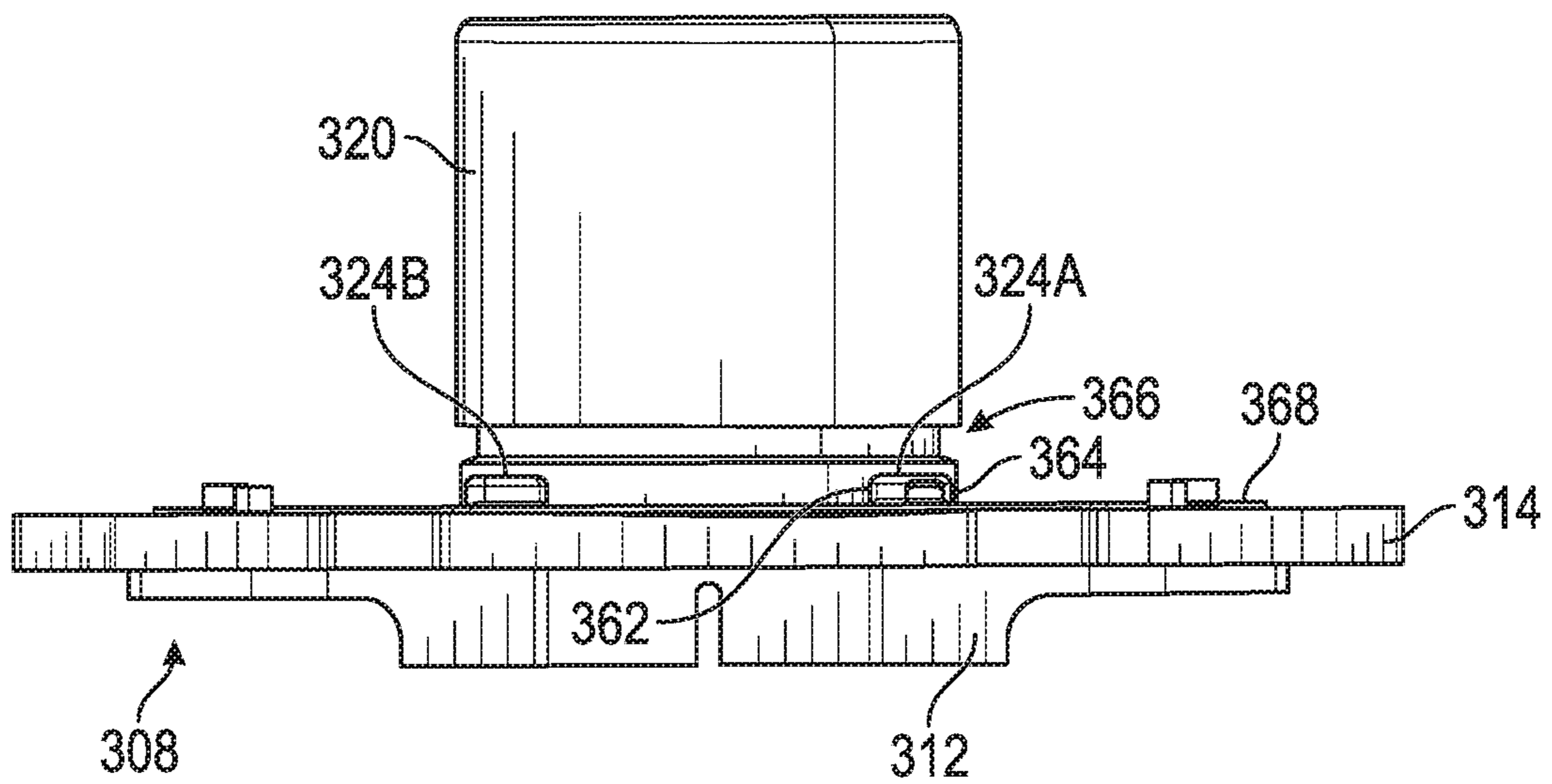


FIG. 16

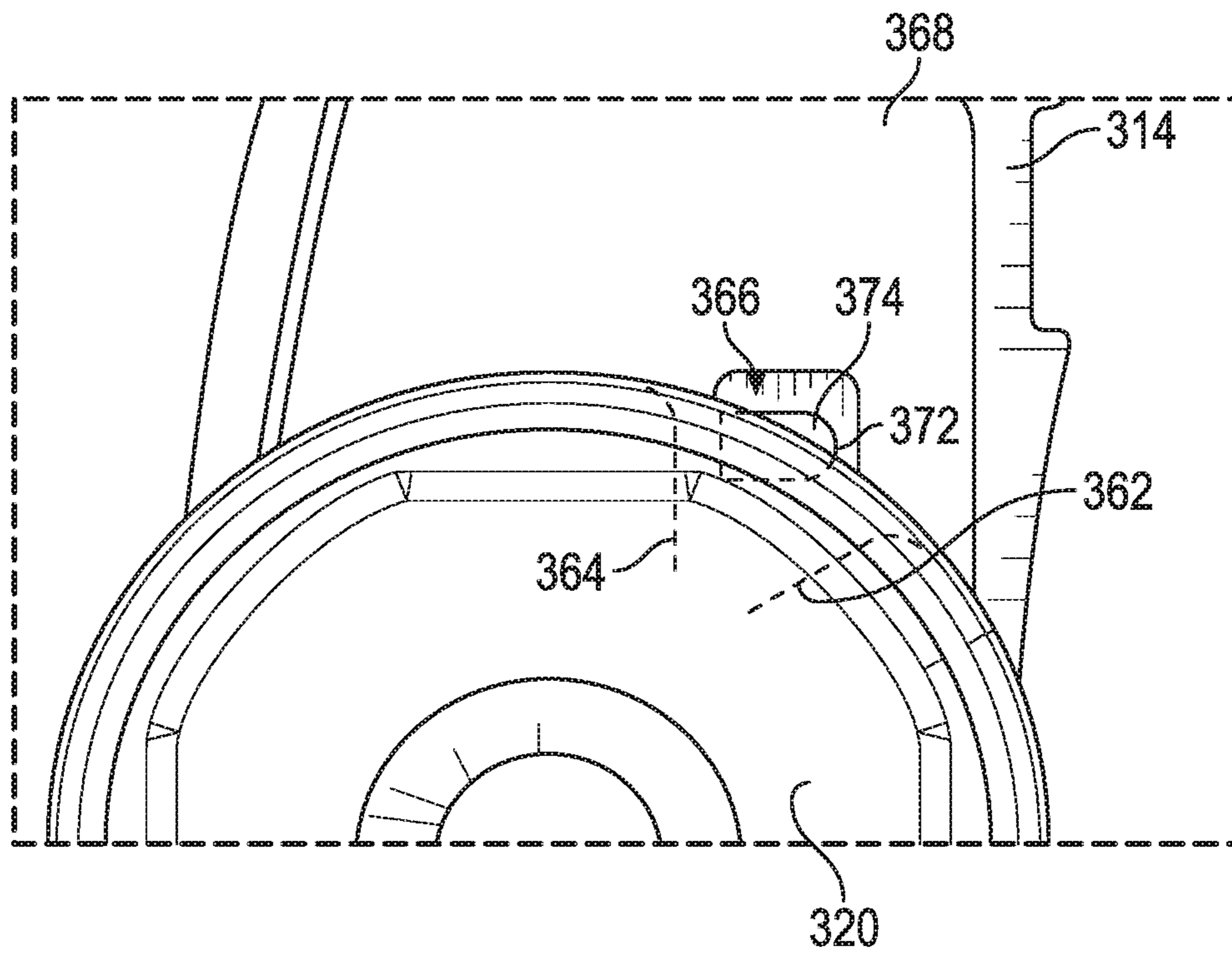


FIG. 17

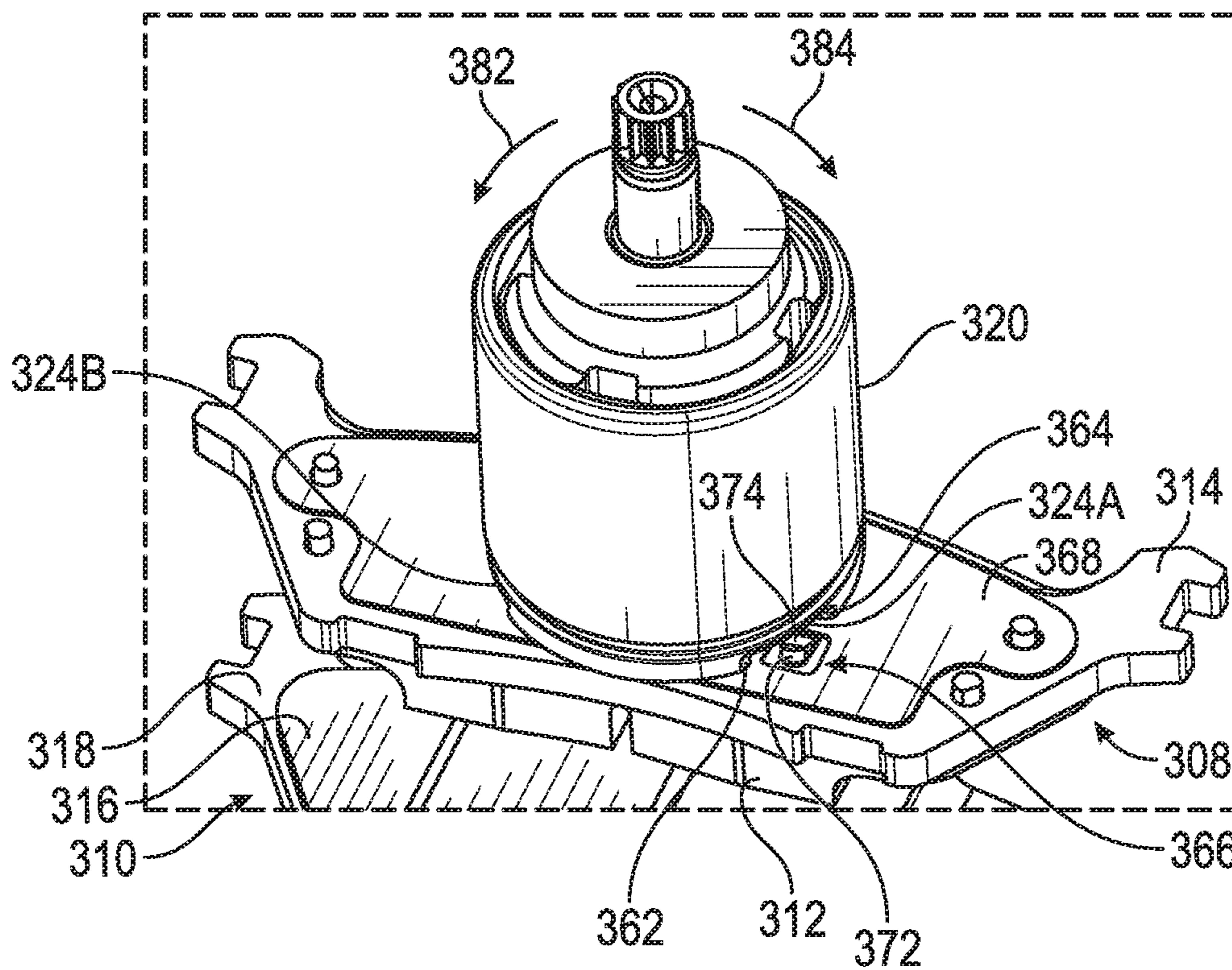


FIG. 18

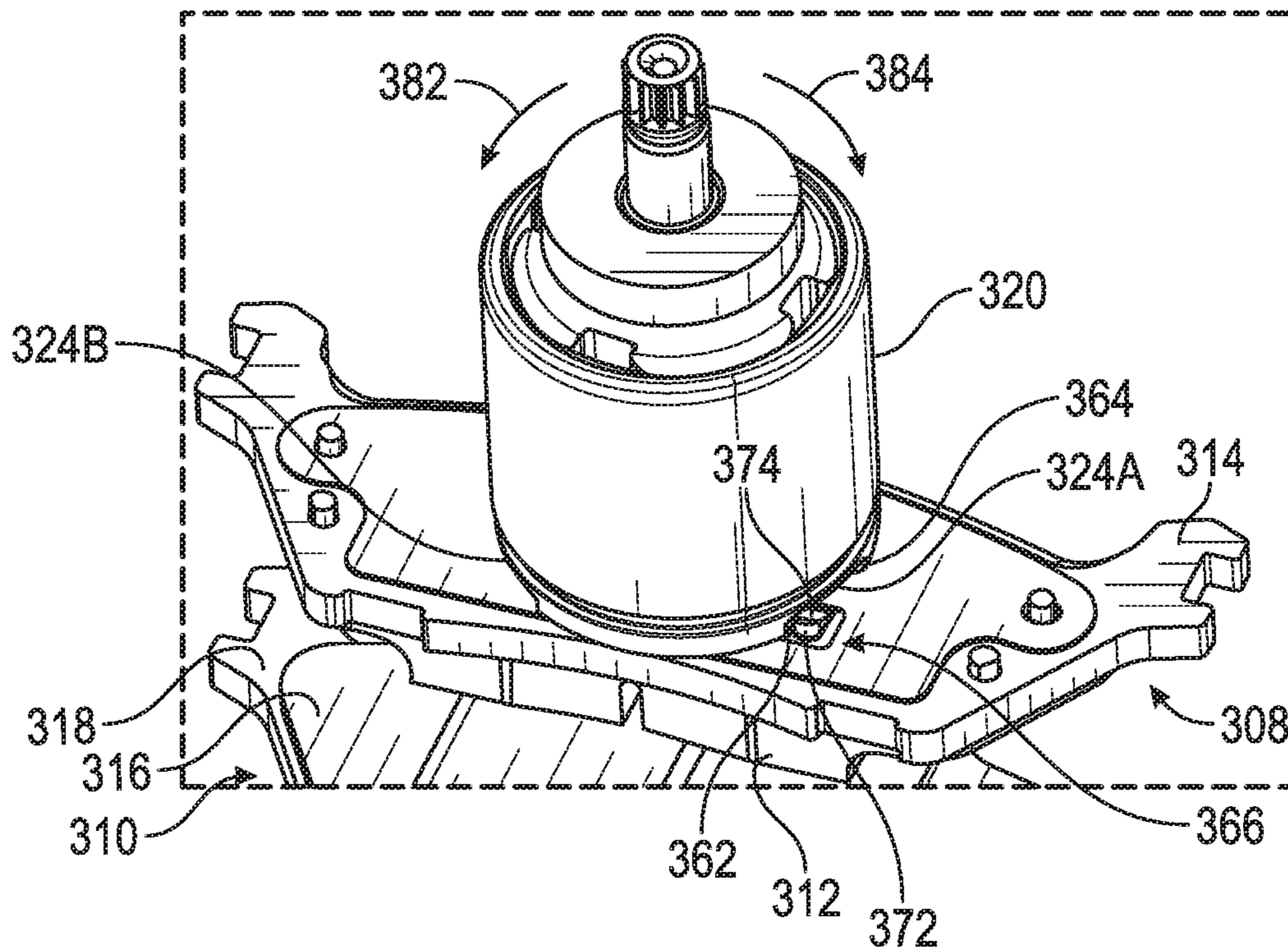


FIG. 19

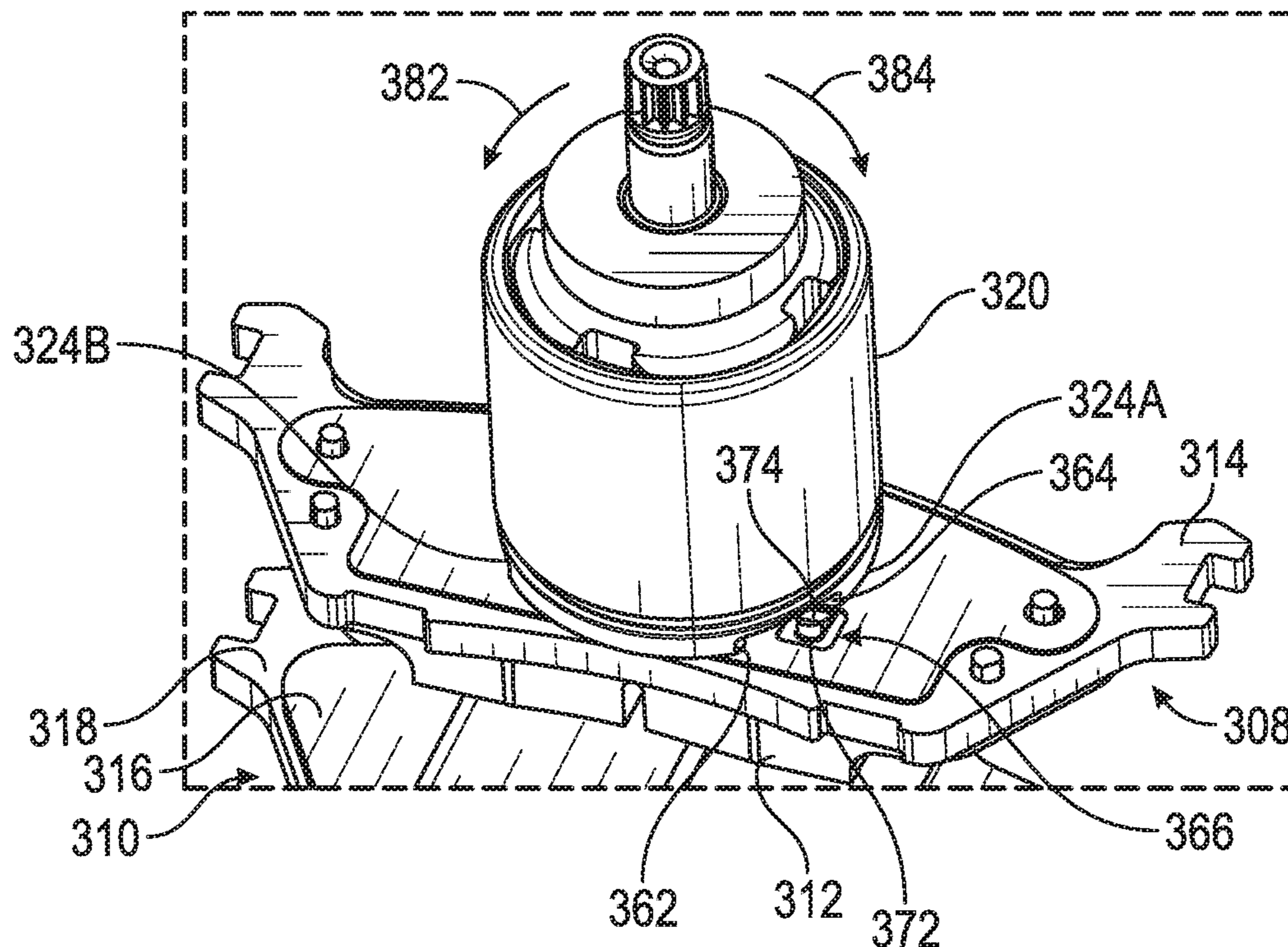


FIG. 20

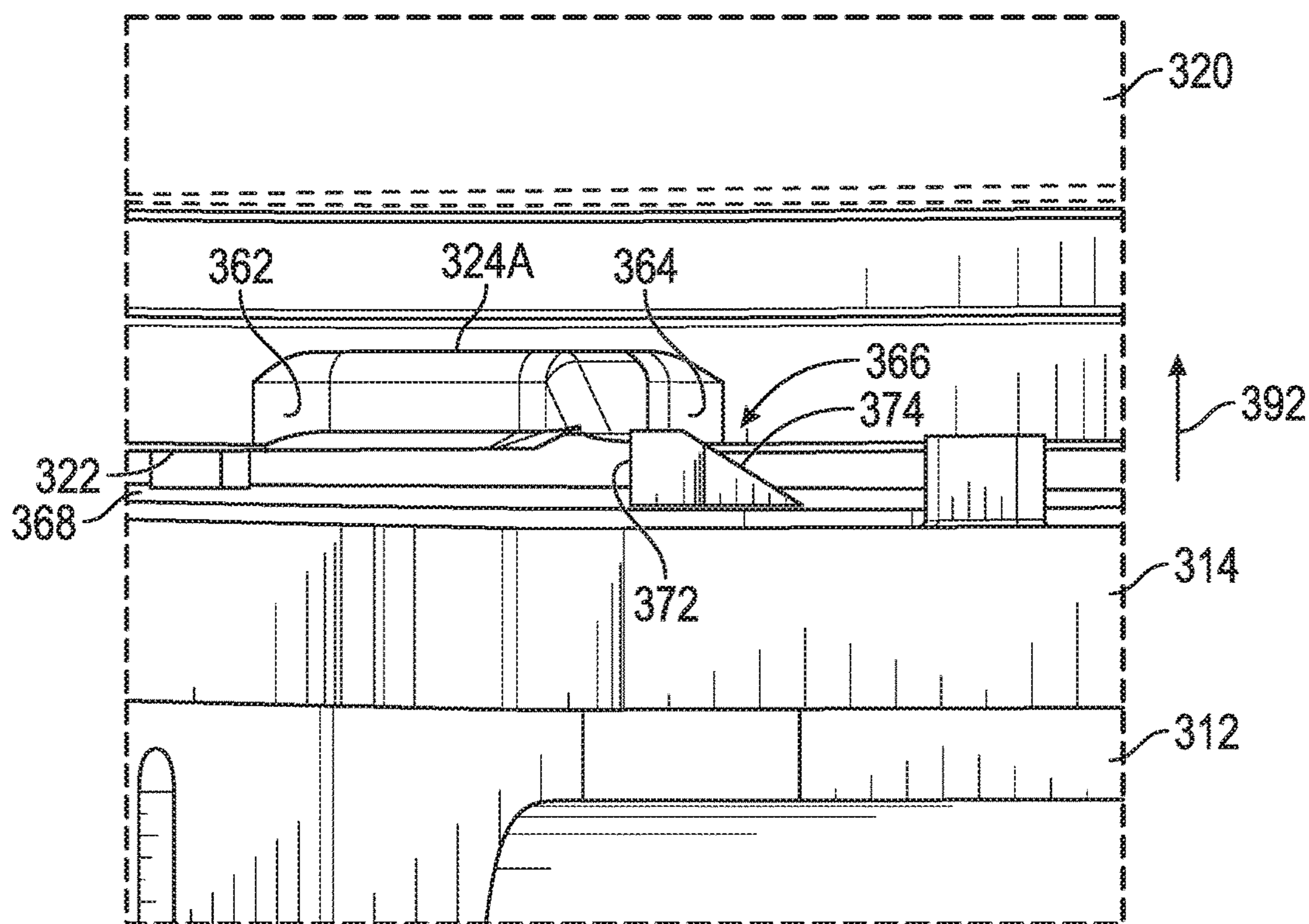


FIG. 21

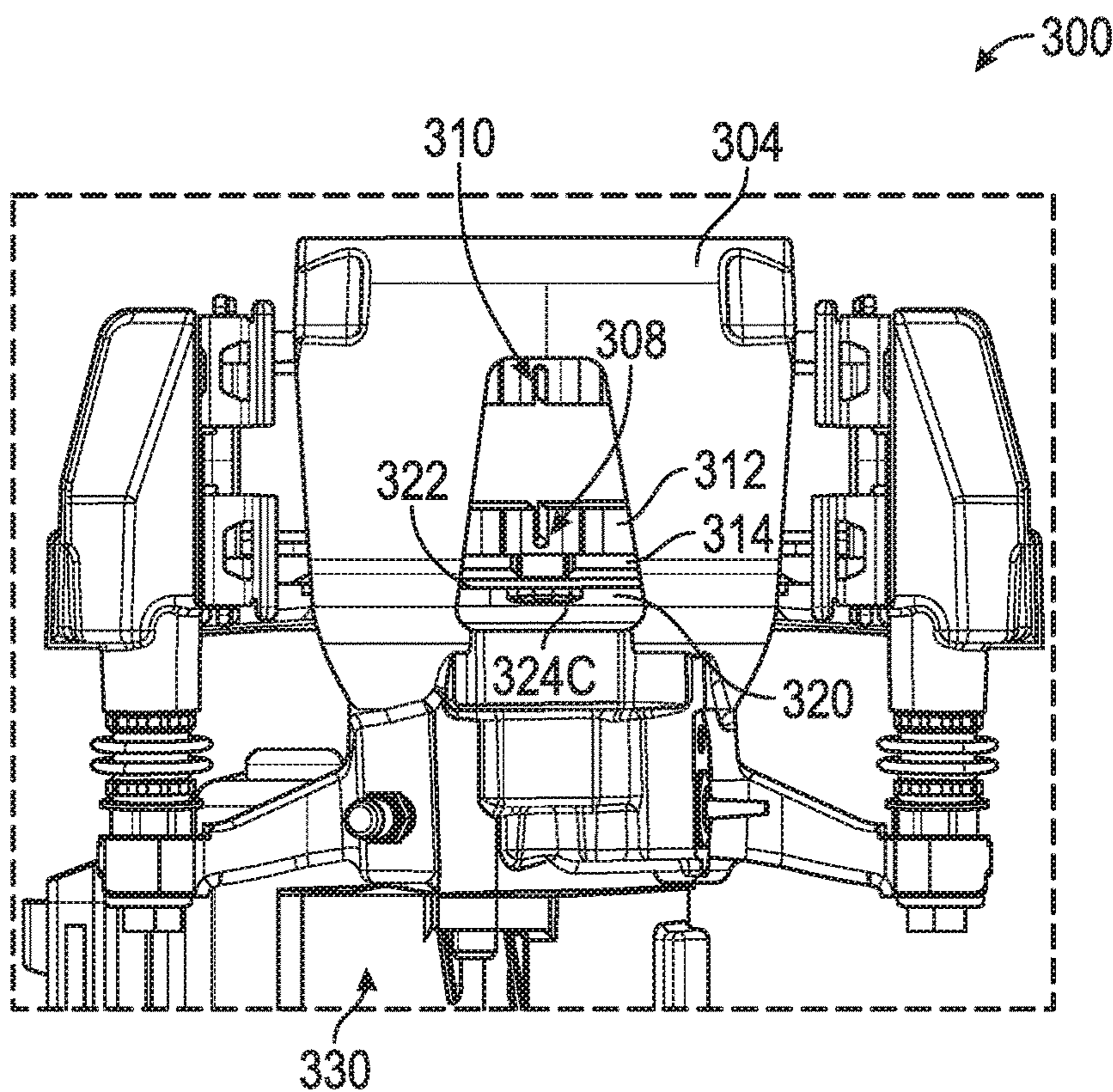


FIG. 22

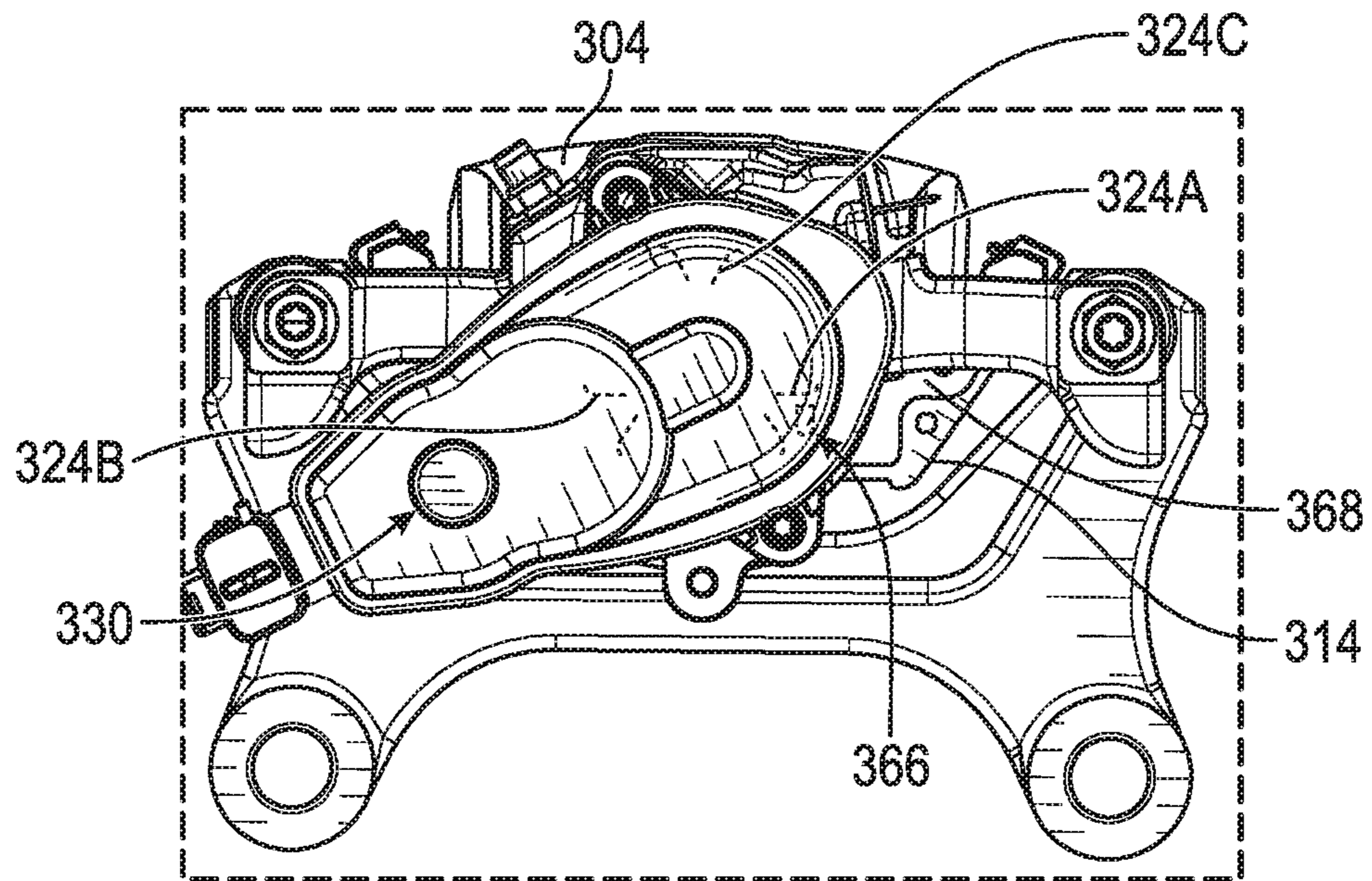


FIG. 23

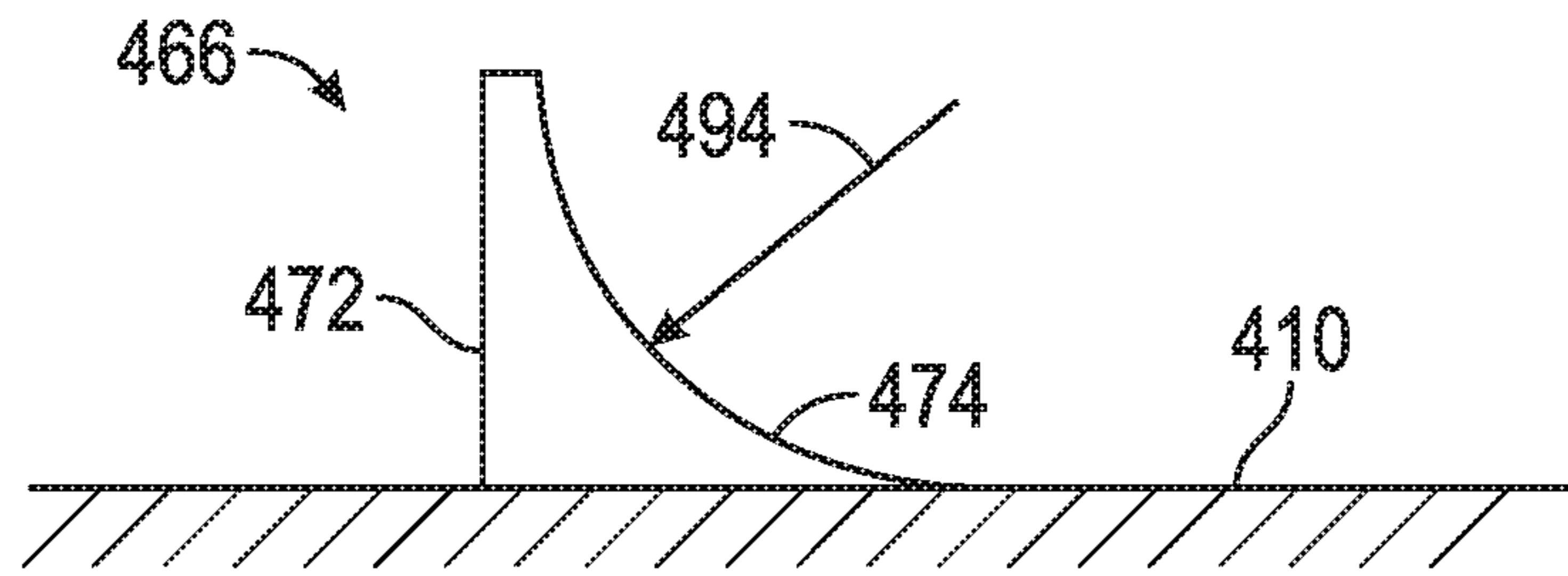


FIG. 24

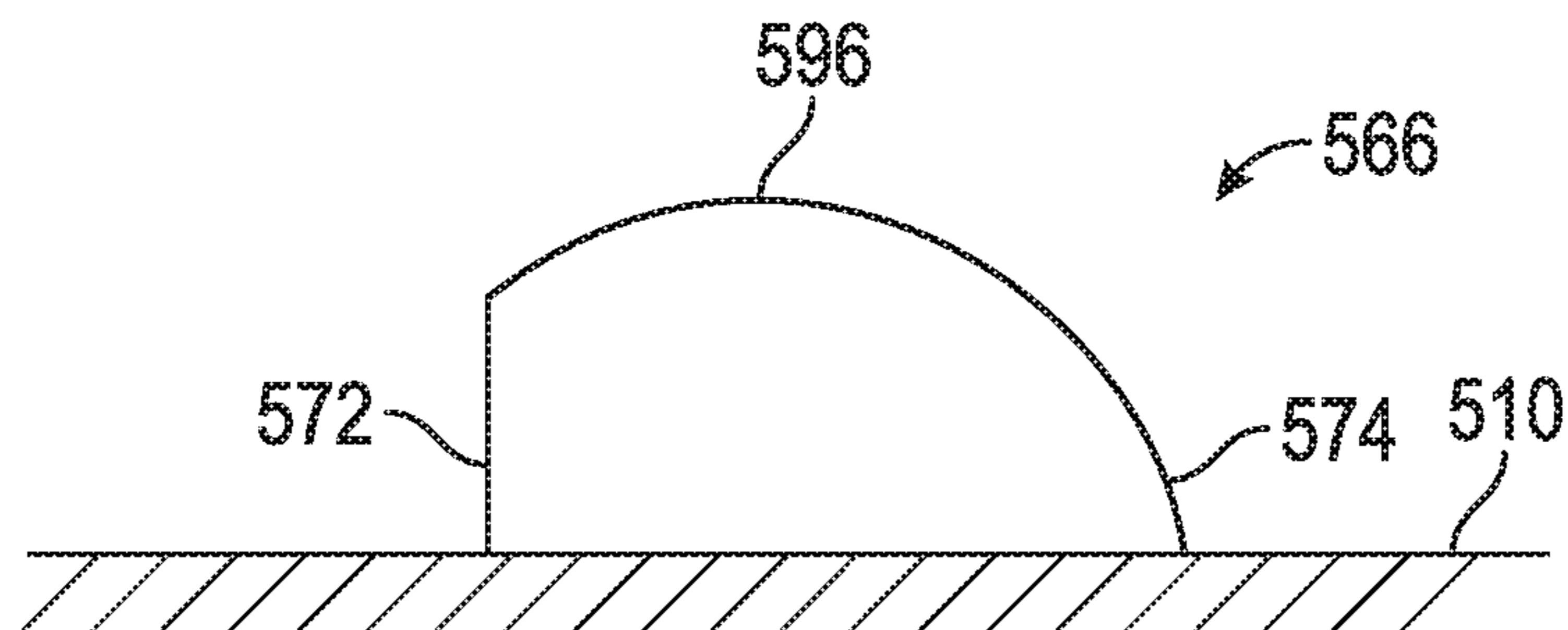


FIG. 25

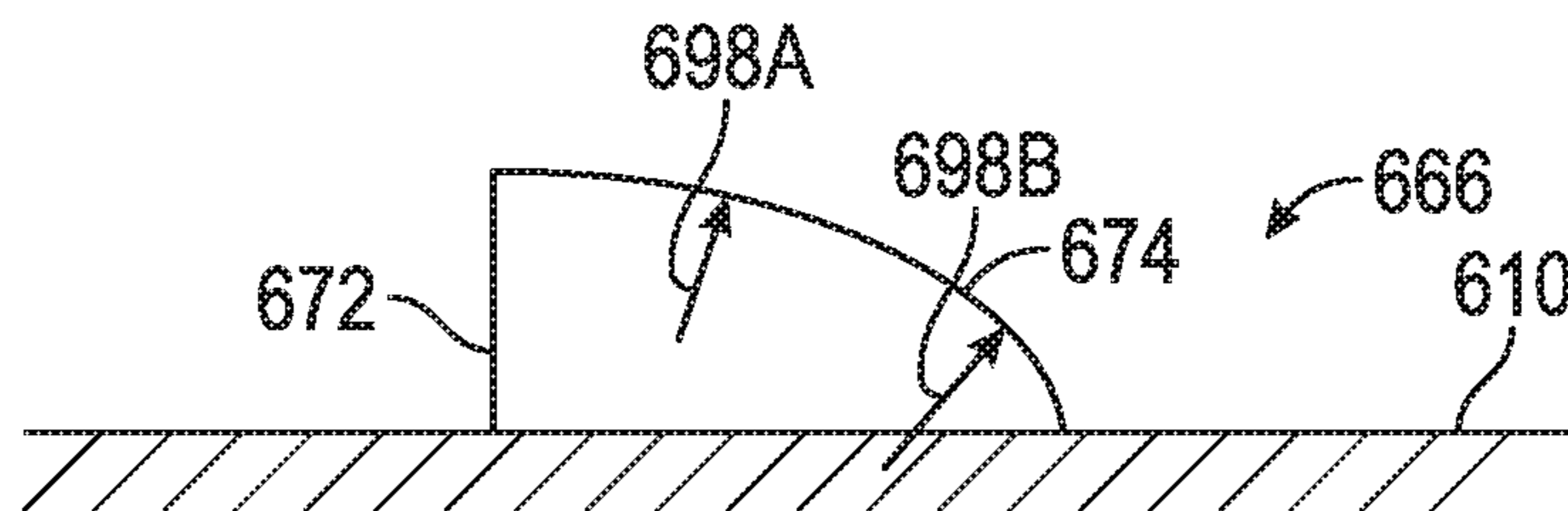


FIG. 26

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**UNI-DIRECTIONAL ANTI-ROTATION
MEMBER FOR A DISC BRAKE ASSEMBLY
WITH AN ELECTRIC PARKING BRAKE**

CROSS REFERENCE TO RELATED
APPLICATIONS

This application is a national stage of International Application No. PCT/US18/067488, filed Dec. 26, 2018, the disclosure of which is incorporated herein by reference in its entirety, and which claimed priority to U.S. Provisional Patent Application No. 62/610,968, filed Dec. 28, 2017, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND OF INVENTION

This invention relates in general to vehicle disc brake assemblies and in particular to an improved anti-rotation member for use with a parking brake function of such a disc brake assembly.

A typical disc brake assembly for a vehicle includes a brake disc which is secured to a wheel of the vehicle for rotation therewith and non-rotating brake linings that are operable between non-braking and braking positions. Each of the brake linings is supported on a brake shoe. In the non-braking position, the brake linings do not slow rotation of the brake disc. In the braking position, the brake linings are in frictional engagement with the brake disc to slow rotation of the brake disc. The brake linings are moved into frictional engagement with the brake disc by a brake piston and a sliding caliper of the disc brake assembly. For example, hydraulic pressure may linearly actuate the brake piston to displace the brake linings to frictionally engage the brake disc and provide braking. Typically, the brake piston displaces an inboard brake lining directly and an outboard brake lining via the caliper.

The disc brake assembly may also provide a parking brake function by first moving the brake linings into the braking position and then using an electric parking brake (EPB) to support the brake piston. The EPB may comprise a rotationally restrained spindle nut threaded onto a spindle driven by an electric motor. As the spindle is rotationally driven, the spindle nut axially translates to support the brake piston on the brake linings in the braking position. An end face of the brake piston contacts one of the brake shoes to support the brake linings in the braking position.

When the end face contacts the brake shoe, torque from the motor is transferred to the end face. The brake piston may rotate or spin when friction between the end face and the brake shoe is insufficient to resist the torque. The brake shoe typically has a backing plate which the brake lining is supported on and the end face contacts. To stop rotation of the brake piston, an anti-rotation member, in the form of an outwardly protruding pip, is provided on the backing plate. Rotation of the brake piston is positively prevented when the pip engages a recessed area—e.g., notch—provided in the end face. However, the pip must be properly aligned with the recessed area during manufacturing of the disc brake assembly. Otherwise, caliper drag, damage to the end face, damage to the brake lining, noise, premature wear of the brake lining, and/or tapered wear of the brake lining may result. This alignment requirement increases complexity and reduces efficiency for manufacturing the disc brake assembly.

Furthermore, for servicing of the caliper, the motor is operated in reverse until the spindle contacts a spindle stop.

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When the spindle contacts the spindle stop, the brake piston will spin because there is no friction between the end face and the brake shoe to stop the spinning. The spinning brake piston may strike the pip on the backing plate. This impact may damage the spindle. Therefore it would be desirable to have a disc brake assembly with an anti-rotation member that is more efficient to manufacture and also reduces damage and/or wear.

SUMMARY OF INVENTION

This invention relates to an anti-rotation member of a disc brake assembly for a parking brake function.

According to one embodiment, a disc brake assembly may comprise, individually and/or in combination, one or more of the following features: a brake shoe displaceable along an axis, an anti-rotation member extending outward from the brake shoe and having a stop surface and a diversion surface, a displaceable brake piston that supports the brake shoe, an end face of the brake piston perpendicular to the axis and facing the brake shoe, and a recessed area in the end face. The recessed area engages the stop surface to stop rotation of the brake piston in a first direction and the recessed area engages the diversion surface to allow rotation of the brake piston in a second direction. The first and second directions are opposite.

According to this embodiment, the diversion surface deflects towards the brake shoe when engaged by the recessed area.

According to this embodiment, a spring force returns the diversion surface away from the brake shoe when the recessed area disengages the diversion surface.

According to this embodiment, the stop surface deflects with the diversion surface.

According to this embodiment, the anti-rotation member deflects towards the brake shoe when the diversion surface is engaged by the recessed area.

According to this embodiment, the anti-rotation member is connected to the brake shoe by a bend portion that biases the anti-rotation member away from the brake shoe.

According to this embodiment, the disc brake assembly may further comprise a first distance from the brake shoe to the diversion surface and a second distance from the brake shoe to the diversion surface. The first and second distances are parallel to the axis. The first distance is greater than the second distance. The first distance is between the stop surface and the second distance.

According to this embodiment, the stop surface is a first plane parallel to the axis and the diversion surface is a second plane transverse to the axis.

According to this embodiment, the diversion surface is a curved surface.

According to this embodiment, the diversion surface has a varying radius.

According to this embodiment, the anti-rotation member extends from a backing plate of the brake shoe.

According to this embodiment, the anti-rotation member extends from a shim of the brake shoe.

According to this embodiment, the recessed area is recessed into the end face away from the brake shoe.

According to this embodiment, rotation of the brake piston in the first direction positions the brake piston to support the brake shoe and rotation of the brake piston in the second direction displaces the brake piston away from the brake shoe.

According to this embodiment, the disc brake assembly may further comprise a spindle nut displaceable along the

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axis to support the brake piston on the brake shoe, a spindle upon which the spindle nut is threaded, and a drive assembly that rotates the spindle to displace the spindle nut along the axis.

According to another embodiment, a disc brake assembly may comprise, individually and/or in combination, one or more of the following features: a brake shoe displaceable along an axis, an anti-rotation member extending outward from the brake shoe and having a stop surface and a diversion surface, a displaceable brake piston that supports the brake shoe, an end face of the brake piston perpendicular to the axis and facing the brake shoe, and a recessed area in the end face. The recessed area engages the stop surface to stop rotation of the brake piston in a first direction and the recessed area engages the diversion surface to allow rotation of the brake piston in a second direction. The first and second directions are opposite. The anti-rotation member deflects towards the brake shoe when the diversion surface is engaged by the recessed area.

According to this embodiment, the anti-rotation member is biased away from the brake shoe.

According to another embodiment, a disc brake assembly may comprise, individually and/or in combination, one or more of the following features: a caliper having a cavity, inboard and outboard brake shoes displaceable along an axis, brake linings mounted to the inboard and outboard brake shoes, a brake piston mounted in the cavity for displacing the inboard and outboard brake shoes and supporting the inboard brake shoe, an end face of the brake piston perpendicular to the axis and facing the inboard brake shoe, a recessed area in the end face, and an anti-rotation member extending outward from the inboard brake shoe and having a stop surface and a diversion surface. The recessed area engages the stop surface to stop rotation of the brake piston in a first direction and the recessed area engages the diversion surface to allow rotation of the brake piston in a second direction. The first and second directions are opposite.

According to this embodiment, the diversion surface deflects towards the inboard brake shoe when engaged by the recessed area.

According to this embodiment, the disc brake assembly may further comprise a spindle nut displaceable along the axis to support the brake piston on the inboard brake shoe, a spindle upon which the spindle nut is threaded, and a drive assembly that rotates the spindle to displace the spindle nut along the axis.

An advantage of an embodiment is more efficient manufacturing of the disc brake assembly. A further advantage of an embodiment is reduced wear and/or damage of the disc brake assembly. Other advantages of this invention will become apparent to those skilled in the art from the following detailed description of the preferred embodiments, when read in light of the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a sectional perspective view of a disc brake assembly having a prior art anti-rotation member for an electric parking brake.

FIG. 2 is a sectional view taken along line 2-2 of FIG. 1.

FIG. 3 is a perspective view of the anti-rotation member of the disc brake assembly of FIG. 1.

FIG. 4 is a perspective view of an end face of a brake piston of the disc brake assembly of FIG. 1.

FIG. 5 is a perspective view of the anti-rotation member of FIG. 3 engaged with the end face of FIG. 4.

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FIG. 6 is a perspective view of an anti-rotation member in accordance with a first embodiment of the present invention.

FIG. 6A is an enlarged portion of FIG. 6.

FIG. 7 is a first elevation view of the anti-rotation member of FIG. 6.

FIG. 8 is a second elevation view of the anti-rotation member of FIG. 6.

FIG. 9 is a perspective view of the anti-rotation member of FIG. 6 in a first operating position.

FIG. 10 is a perspective view of the anti-rotation member of FIG. 6 in a second operating position.

FIG. 11 is a perspective view of the anti-rotation member of FIG. 6 in a third operating position.

FIG. 12 is an elevation view of the anti-rotation member of FIG. 6 in the third operating position.

FIG. 13 is a first elevation view of a disc brake assembly having the anti-rotation member of FIG. 6.

FIG. 14 is a second elevation view of the disc brake assembly of FIG. 13.

FIG. 15 is a perspective view of an anti-rotation member in accordance with a second embodiment of the present invention.

FIG. 15A is an enlarged portion of FIG. 15.

FIG. 16 is a first elevation view of the anti-rotation member of FIG. 15.

FIG. 17 is a second elevation view of the anti-rotation member of FIG. 15.

FIG. 18 is a perspective view of the anti-rotation member of FIG. 15 in a first operating position.

FIG. 19 is a perspective view of the anti-rotation member of FIG. 15 in a second operating position.

FIG. 20 is a perspective view of the anti-rotation member of FIG. 15 in a third operating position.

FIG. 21 is an elevation view of the anti-rotation member of FIG. 15 in the third operating position.

FIG. 22 is a first elevation view of a disc brake assembly having the anti-rotation member of FIG. 15.

FIG. 23 is a second elevation view of the disc brake assembly of FIG. 22.

FIG. 24 is an elevation view of an anti-rotation member in accordance with a third embodiment of the present invention.

FIG. 25 is an elevation view of an anti-rotation member in accordance with a fourth embodiment of the present invention.

FIG. 26 is an elevation view of an anti-rotation member in accordance with a fifth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 and 2, there is illustrated a disc brake assembly, indicated generally at **100**, having a prior art anti-rotation member in the form of a pip **102**. The general structure and operation of the disc brake assembly **100** is well known in the prior art. For example, the disc brake assembly **100** may be such as is disclosed by U.S. Pat. No. 8,844,683 to Sternal et al., U.S. Patent Application Publication No. 2017/0261053 to Schaefer et al., or U.S. Patent Publication No. 2018/0087589 to Gerber et al, the disclosures of all of which are hereby incorporated by reference in entirety herein.

The disc brake assembly **100** includes a sliding caliper **104**. The caliper **104** is mounted in a floating manner by means of a brake carrier (not shown) in a manner known to

those skilled in the art. The caliper **104** also spans a brake disc **106** that is coupled to a vehicle wheel (not shown) in a rotationally fixed manner.

Provided in the caliper **104** are outboard and inboard brake shoes, indicated generally at **108** and **110**, respectively. The outboard brake shoe **108** has an outboard brake lining **112** supported on an outboard backing plate **114**. Similarly, the inboard brake shoe **110** has an inboard brake lining **116** supported on an inboard backing plate **118**. The outboard backing plate **114** bears on the caliper **104** and the inboard backing plate **118** bears on a brake piston **120**. The outboard and inboard brake linings **112** and **116**, respectively, face towards each other and, in a release position, are disposed with a small air clearance on both sides of the brake disc **106**, such that no significant residual drag moments occur on the brake disc **106**. The inboard backing plate **118** is disposed between the inboard brake lining **116** and the brake piston **120** such that the inboard brake lining **116** and the brake piston **120** move jointly.

The pip **102** protrudes outwardly from the inboard backing plate **118**. The pip **102** will be discussed further with reference to FIGS. **3** and **5**. The brake piston **120** has an end face **122**. The end face **122** faces the inboard brake shoe **110**. Provided in the end face **122** are first and second recessed areas—i.e., notches or pockets—**124A** and **124B**, respectively, for receiving the pip **102**. The first and second recessed areas **124A** and **124B**, respectively, are recessed into the end face **122** away from the inboard brake shoe **110**. The first and second recessed areas **124A** and **124B**, respectively, will be discussed further with reference to FIGS. **4** and **5**.

The brake piston **120** is mounted in a movable manner in a preferably cylindrical cavity **126** in the caliper **104**. In addition, it can be seen that the brake piston **120** is realized so as to be hollow. Accommodated in the brake piston **120** is a rotationally restrained spindle nut, indicated generally at **128**, of an electric parking brake (EPB), indicated generally at **130**. The EPB **130** preferably includes a drive assembly **132** having a suitable power source and transmission assembly known to those skilled in the art. As a non-limiting example, the power source may be an electric motor.

A spindle, indicated generally at **134**, is operatively connected to the drive assembly **132**, supported via an axial bearing **136**, and accommodated in a threaded manner in a threaded receiver **138** of the spindle nut **128**. An output shaft **140** of the drive assembly **132** rotationally drives the spindle **134**. This results in movement of the spindle nut **128** along a longitudinal axis **142** because the spindle nut **128** is rotationally restrained. An external surface **144** of the spindle nut **128** is preferably cylindrical. The inboard and outboard brake shoes **108** and **112**, respectively, as well as the brake piston **120**, are also displaceable along the longitudinal axis **142**.

The spindle nut **128** has a conical portion **146** which can be brought into bearing contact with a complementary conical inner portion **148** of the brake piston **120**. In the release position, there is a clearance **150** between the conical portion **146** and the conical inner portion **148**. The construction, shape, configuration, and/or make-up of the conical portion **146** and the complementary conical inner portion **148** may be other than as illustrated and described, if so desired. For example, the conical portion **146** and the conical inner portion **148** may have other, non-conical, complimentary shapes.

When service braking is desired for a vehicle having the disc brake assembly **100**, the disc brake assembly **100** is hydraulically actuated. For example, the disc brake assem-

bly **100** may be hydraulically actuated by a driver via a brake pedal or via a drive assistance system. When the disc brake assembly **100** is hydraulically actuated, hydraulic fluid is pressurized (by a suitable means known to those skilled in the art) in the cavity **126** such that the brake piston **120** is displaced leftward in FIG. **2** along the longitudinal axis **142**. As a consequence, and as is known to those skilled in the art, the inboard brake lining **116** is pressed onto the brake disc **106** by the brake piston **120** (i.e., by the end face **122**) and, at the same time, a corresponding displacement of the caliper **104** on an opposite side of the brake disc **106** causes the outboard brake lining **112** to be drawn against the opposite side of the brake disc **106**. As a result of the application of the pressurized hydraulic fluid to the cavity **126**, the brake piston **120** has been displaced leftward in FIG. **2**, along the longitudinal axis **142** towards the brake disc **106** and into an active braking position. The spindle nut **128** remains unactuated, and therefore remains at an initial axial position in FIG. **2**.

For activating a parking brake function of the disc brake assembly **100**, in a manner similar to service braking, the brake piston **120** is first put into the active braking position through application of hydraulic pressure. Actuation of the EPB **130** then causes the drive assembly **132** to displace the spindle nut **128** towards the brake disc **106** until the clearance **150** has been used up and the conical portion **146** bears on the corresponding conical inner portion **148** inside the brake piston **120**. As a result, the brake piston **120** is axially supported, via the spindle nut **128** and the axial bearing **136**, on the housing of the caliper **104** in a parking brake state.

Once the brake piston **120** is axially supported, the hydraulic pressure in the cavity **126** can be removed. The parking brake state is maintained because of the position of the spindle nut **128** and because of self-arresting (for example, by a self-arresting transmission between the spindle **134** and the receiver **138**). The outboard and inboard brake linings **112** and **116**, respectively, pressing against the brake disc **106** are supported via the spindle nut **128**.

When the parking brake state is to be released, pressurized hydraulic fluid is again introduced into the cavity **126**. As a result, the brake piston **120** is displaced slightly leftward, along the longitudinal axis **142**, towards the brake disc **106** such that the spindle nut **128** is relieved of axial load. Through control of the EPB **130**, the spindle nut **128** can then be displaced back into the initial axial position illustrated in FIG. **2**.

Referring now to FIG. **3**, there is illustrated the pip **102** in detail. The pip **102** is symmetric across a line **152**. As illustrated, the pip **102** is a cylinder with a constant height **154** and a constant diameter **156**. The pip **102** has first and second stop surfaces **158** and **160**, respectively. The first and second stop surfaces **158** and **160**, respectively, are each parallel to the axis **142**.

Referring now to FIG. **4**, there are illustrated the first and second recessed areas **124A** and **124B**, respectively, in detail. As discussed, the first and second recessed areas **124A** and **124B**, respectively, are recessed into the end face **122**. Each of the first and second recessed areas **124A** and **124B**, respectively, have first and second contact surfaces **162** and **164**, respectively.

Referring now to FIG. **5**, there is illustrated the first contact surface **162** of the first recessed area **119A** in contact with the first stop surface **158**. Such occurs when the end face **122** contacts the inboard backing plate **118** when the parking brake function is activated.

Referring now to FIGS. **6-8**, there is illustrated an outboard brake shoe, indicated generally at **208**, an inboard

brake shoe, indicated generally at **210**, and a brake piston **220** with an end face **222**. The outboard brake shoe **208**, the inboard brake shoe **210**, the brake piston **220**, and the end face **222** are variations of the outboard brake shoe **108**, the inboard brake shoe **110**, and the brake piston **120** of FIGS. **1-5**. As such, like reference numerals, increased by 100, designate corresponding parts in the drawings and detailed description thereof will be omitted.

Also illustrated in FIGS. **6-8** is a first embodiment of an anti-rotation member, indicated generally at **266**, produced in accordance with the present invention and for use with a disc brake assembly. As a non-limiting example, the anti-rotation member **266** may be used with the prior art disc brake assembly **100** of FIGS. **1-5** in lieu of the pip **102**.

The inboard brake shoe **210** includes a pad noise shim **268** mounted to an inboard backing plate **218**. The anti-rotation member **266** extends from the shim **268** and towards the brake piston **220**. The anti-rotation member **266** is connected to the shim **268** by a bend portion **270** that biases the anti-rotation member **266** away from the inboard brake shoe **210**. The bend portion **270** biases the anti-rotation member **266** to a position shown in FIGS. **6-8**.

Preferably, the anti-rotation member **266** is formed as a portion of the shim **268**. As non-limiting examples, the anti-rotation member **266** may be stamped or cut from the shim **268**. As non-limiting examples, the shim **268** (as well as the anti-rotation member **266**) may be fabricated from metallic or plastic material.

The anti-rotation member **266** includes a stop surface **272** and a diversion surface **274**. The stop surface **272** forms a first plane that is parallel to a longitudinal axis **242**. The diversion surface **274** forms a second plane that is transverse to the longitudinal axis. As a result, the diversion surface **274** is not parallel to the stop surface **272** or the longitudinal axis **242**. Instead, the diversion surface **274** is inclined or sloped. Although each of the stop surface **272** and the diversion surface **274** are illustrated and described as planes, such is not necessary. Alternatively, one or both of the stop surface **272** and/or the diversion surface **274** may be other than planar. Non-planar shapes for the anti-rotation member **266** will be discussed with reference to FIGS. **24-26**.

Referring specifically to FIG. **6A**, a first distance **276** is from the inboard backing plate **218** to the diversion surface **274** adjacent the stop surface **272**. A second distance **278** is from the inboard backing plate **218** to the diversion surface **274** between the first distance **276** and the bend portion **270**. The first and second distances **276** and **278**, respectively, are parallel to the longitudinal axis **242**. The first distance **276** is between the stop surface **272** and the second distance **278**. The first distance **276** is greater than the second distance **278**. Preferably, when the second distance **278** is at an end **280** of the diversion surface **274** opposite the stop surface **272**, the second distance **278** is zero. Preferably, the first distance **276** is measured along the axis **242** at a furthest extent of the anti-rotation member **266** from the inboard brake shoe **110**.

Referring now to FIG. **9**, there is illustrated a first operating position of the anti-rotation member **266**. In the first operating position, the brake piston **220** has contacted the shim **268**. Neither first nor second contact surfaces **262** or **264**, respectively, of a first recessed area **224A** are engaged with the anti-rotation member **266**. As a result, the brake piston **220** is free to rotate in first or second directions **282** or **284**, respectively. When rotating in the first direction **282**, the brake piston **220** displaces to support the inboard brake

shoe **210**. When rotating in the second direction **284**, the brake piston **220** displaces away from the inboard brake shoe **210**.

Referring now to FIG. **10**, there is illustrated a second operating position of the anti-rotation member **266**. In the second operating position, the brake piston **220** remains in contact with the shim **268**. The brake piston **220** has rotated in the first direction **282** until the first contact surface **262** has engaged the stop surface **272**. When the first contact surface **262** engages the stop surface **272**, further rotation of the brake piston **220** in the first direction **282** is positively prevented. The first contact surface **262** engaging the stop surface **272** stops the brake piston **220** from rotation in the first direction **276**.

Referring now to FIGS. **11** and **12**, there is illustrated a third operating position of the anti-rotation member **266**. In the third operating position, the brake piston **220** continues to be in contact with the shim **268**. The brake piston **220** has now rotated in the second direction **284** until the second contact surface **264** has engaged the diversion surface **274**. When the second contact surface **264** engages the diversion surface **274**, further rotation of the brake piston **220** in the second direction **284** is allowed.

Continued rotation of the brake piston **220** in the second direction **284** when the second contact surface **264** engages the diversion surface **274** is because the anti-rotation member **266** deflects in a deflection direction **286** towards the inboard brake shoe **210**. Specifically, the diversion surface **274** deflects in the deflection direction **286** by rotating about the bend portion **270**. The stop surface **272** is rigidly connected to the diversion surface **274** such that the stop surface **272** also deflects in the deflection direction **286** when the second contact surface **264** engages the diversion surface **274**.

The deflection of the anti-rotation member **266** in the deflection direction **286** is against a spring force **288**. The spring force **288** biases the anti-rotation member **266** to the position illustrated in FIG. **9** when the second contact surface **264** disengages—or is otherwise not engaged with—the diversion surface **274**. The spring force **288** returns the diversion surface **274** away from the inboard brake shoe **210** when the second contact surface **264** disengages from the diversion surface **274**. The spring force **288** is generated by the bend portion **270**.

The anti-rotation member **266** need not progress through the first, second, and third operating positions in numerical order. The anti-rotation member **266** typically changes between the first operating position and the second or third operating position. The anti-rotation member **266** changes between the second and third operating positions through the first operating position.

Referring now to FIGS. **13** and **14**, there is illustrated alignment of the anti-rotation member **266** and the first recessed area **224A**. Also illustrated are positions of second and third recessed areas **224B** and **224C**, respectively. In FIGS. **13** and **14**, the inboard brake shoe **110** and the brake piston **220** are positioned relative to each other for manufacturing of a disc brake assembly, indicated generally at **200**.

The anti-rotation member **266** has been described for a disc brake assembly that is provided with an electric parking brake. Alternatively, the anti-rotation member **266** may be provided for a disc brake assembly with the electric parking brake omitted.

Referring now to FIGS. **15-23**, there is illustrated a second embodiment of an anti-rotation member, indicated generally at **366**, produced in accordance with the present

invention and for use with a disc brake assembly. As a non-limiting example, the anti-rotation member **366** may be used with the prior art disc brake assembly **100** of FIGS. **1-5** in lieu of the pip **102**. It will be appreciated that this invention may be used in connection with other types or kinds of disc brake assemblies, if so desired.

The anti-rotation member **366** is illustrated with an outboard brake shoe, indicated generally at **308**, an inboard brake shoe, indicated generally at **310**, and a brake piston **320** with an end face **322**. The outboard brake shoe **308**, the inboard brake shoe **310**, and the brake piston **320** are variations of the outboard brake shoe **208**, the inboard brake shoe **210**, the brake piston **220**, and the end face **222** of FIGS. **6-14**. As such, like reference numerals, increased by **100**, designate corresponding parts in the drawings and detailed description thereof will be omitted.

The inboard brake shoe **308** includes an inboard backing plate **318**. The anti-rotation member **366** extends from the inboard backing plate **318** and towards the brake piston **320**. As illustrated, the anti-rotation member **366** extends through an opening **390** in a pad noise shim **368**. The anti-rotation member **366** is formed from the inboard backing plate **318** and thus is rigidly positioned relative to the inboard backing plate **318**. Preferably, the anti-rotation member **366** is monolithically formed with the inboard backing plate **318** when the inboard backing plate **318** is cast. Alternatively, the anti-rotation member **366** may be other than monolithically formed with the inboard backing plate **318**. As a non-limiting example, the anti-rotation member **366** may be formed as a separate member that is fixed to the inboard backing plate **318** by a suitable means.

Referring specifically to FIGS. **20** and **21**, in a third operating position, a second contact surface **364** of a first recessed area **324A** has engaged a diversion surface **374** of the anti-rotation member **366**. When the second contact surface **364** has engaged the diversion surface **374**, the brake piston **320** continues to rotate in a second direction **384**. As the brake piston **320** continues to rotate in the second direction **384**, the second contact surface **364** translates up—i.e., “rides up”—the diversion surface **374**. When the second contact surface **364** translates up the diversion surface **374**, the brake piston **320** displaces along a longitudinal axis **342** in a displacement direction **392**. The brake piston **320** is able to displace along the longitudinal axis **342** because, during servicing, a spindle nut (e.g., the spindle nut **128** in FIG. **1**) is pulled away from a conical inner portion (e.g., the conical inner portion **148** in FIG. **1**) by a spindle screw. This increases a clearance between the spindle nut and the conical inner portion (e.g., the clearance **150** in FIG. **2**). The increased clearance allows the brake piston **320** to be displaced when the piston brake **320** rides up the diversion surface **374**.

Referring now to FIG. **24**, there is illustrated a third embodiment of an anti-rotation member, indicated generally at **466**, produced in accordance with the present invention. The anti-rotation member **466** is a variation of the anti-rotation member **366** of FIGS. **15-23**. As such, like reference numerals, increased by **100**, designate corresponding parts in the drawings and detailed description thereof will be omitted.

A diversion surface **474** is non-planar—i.e., curved—and has a constant radius **494**. As illustrated, the diversion surface **474** is a concave surface. Alternatively, the diversion surface **474** may be a convex surface. Alternatively, the diversion surface **474** may be a combination of concave and convex surfaces.

Referring now to FIG. **25**, there is illustrated a fourth embodiment of an anti-rotation member, indicated generally at **566**, produced in accordance with the present invention. The anti-rotation member **566** is a variation of the anti-rotation member **366** of FIGS. **15-23**. As such, like reference numerals, increased by **200**, designate corresponding parts in the drawings and detailed description thereof will be omitted.

A diversion surface **574** is non-planar—i.e., curved—and has an apex **596**. As such, a first distance **576** is offset or otherwise separated from a stop surface **572**.

Referring now to FIG. **26**, there is illustrated a fifth embodiment of an anti-rotation member, indicated generally at **666**, produced in accordance with the present invention. The anti-rotation member **666** is a variation of the anti-rotation member **366** of FIGS. **15-23**. As such, like reference numerals, increased by **300**, designate corresponding parts in the drawings and detailed description thereof will be omitted.

A diversion surface **674** is non-planar—i.e., curved—and has a varying radius. As a non-limiting example, the diversion surface **674** has a first radius **698A** and a second radius **698B**, wherein the first radius **698A** is greater than the second radius **698B**.

In accordance with the provisions of the patent statutes, the principle and mode of operation of this invention have been described and illustrated in its preferred embodiments. However, it must be understood that this invention may be practiced otherwise than as specifically explained and illustrated without departing from its spirit or scope.

What is claimed is:

1. A disc brake assembly comprising:

a brake shoe displaceable along an axis;

an anti-rotation member extending outward from the brake shoe and having a stop surface and a diversion surface;

a displaceable brake piston that supports the brake shoe; an end face of the brake piston perpendicular to the axis and facing the brake shoe; and

a recessed area in the end face, wherein the recessed area engages the stop surface to stop rotation of the brake piston in a first direction, the recessed area engages the diversion surface to allow rotation of the brake piston in a second direction, and the first and second directions are opposite, the diversion surface deflecting towards the brake shoe when engaged by the recessed area.

2. The disc brake assembly of claim 1 wherein a spring force returns the diversion surface away from the brake shoe when the recessed area disengages the diversion surface.

3. The disc brake assembly of claim 1 wherein the stop surface deflects with the diversion surface.

4. The disc brake assembly of claim 1 wherein the anti-rotation member deflects towards the brake shoe when the diversion surface is engaged by the recessed area.

5. The disc brake assembly of claim 1 wherein the anti-rotation member is connected to the brake shoe by a bend portion that biases the anti-rotation member away from the brake shoe.

6. The disc brake assembly of claim 1 further comprising: a first distance from the brake shoe to the diversion surface; and

a second distance from the brake shoe to the diversion surface, the first and second distances are parallel to the axis, the first distance is greater than the second distance, and the first distance is between the stop surface and the second distance.

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7. The disc brake assembly of claim 1 wherein the stop surface is a first plane parallel to the axis and the diversion surface is a second plane transverse to the axis.

8. The disc brake assembly of claim 1 wherein the diversion surface is a curved surface.

9. The disc brake assembly of claim 1 wherein the diversion surface has a varying radius.

10. The disc brake assembly of claim 1 wherein the anti-rotation member extends from a backing plate of the brake shoe.

11. The disc brake assembly of claim 1 wherein the anti-rotation member extends from a shim of the brake shoe.

12. The disc brake assembly of claim 1 wherein the recessed area is recessed into the end face away from the brake shoe.

13. The disc brake assembly of claim 1 wherein rotation of the brake piston in the first direction positions the brake piston to support the brake shoe and rotation of the brake piston in the second direction displaces the brake piston away from the brake shoe.

14. The disc brake assembly of claim 1 further comprising:

- a spindle nut displaceable along the axis to support the brake piston on the brake shoe;
- a spindle upon which the spindle nut is threaded; and
- a drive assembly that rotates the spindle to displace the spindle nut along the axis.

15. A disc brake assembly comprising:

- a brake shoe displaceable along an axis;
- an anti-rotation member extending outward from the brake shoe and having a stop surface and a diversion surface;
- a displaceable brake piston that supports the brake shoe;
- an end face of the brake piston perpendicular to the axis and facing the brake shoe; and
- a recessed area in the end face, wherein the recessed area engages the stop surface to stop rotation of the brake

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piston in a first direction, the recessed area engages the diversion surface to allow rotation of the brake piston in a second direction, the first and second directions are opposite, and the anti-rotation member deflects towards the brake shoe when the diversion surface is engaged by the recessed area.

16. The disc brake assembly of claim 15 wherein the anti-rotation member is biased away from the brake shoe.

17. A disc brake assembly comprising:

- a caliper having a cavity;
- inboard and outboard brake shoes displaceable along an axis;
- brake linings mounted to the inboard and outboard brake shoes;
- a brake piston mounted in the cavity for displacing the inboard and outboard brake shoes and supporting the inboard brake shoe;
- an end face of the brake piston perpendicular to the axis and facing the inboard brake shoe;
- a recessed area in the end face; and
- an anti-rotation member extending outward from the inboard brake shoe and having a stop surface and a diversion surface, wherein the recessed area engages the stop surface to stop rotation of the brake piston in a first direction, the recessed area engages the diversion surface to allow rotation of the brake piston in a second direction, and the first and second directions are opposite, the diversion surface deflecting towards the inboard brake shoe when engaged by the recessed area.

18. The disc brake assembly of claim 17 further comprising:

- a spindle nut displaceable along the axis to support the brake piston on the inboard brake shoe;
- a spindle upon which the spindle nut is threaded; and
- a drive assembly that rotates the spindle to displace the spindle nut along the axis.

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